

Clemson University



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CLEMSON UNIVERSITY



ANNUAL REPORT

1987-1988

Printed Under The Direction Of The
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CLEMSON UNIVERSITY CENTENNIAL 1889-1989

PRESIDENT

1987-88 marked the beginning of Clemson University's second century of teaching, research and public service. The official Centennial observance began on April 6, 1988, the 100th anniversary of the death of founder Thomas Green Clemson. Centennial events will continue through November 1989, the 100th anniversary of the state of South Carolina's acceptance of the conditions of Mr. Clemson's will, which provided for the establishment of Clemson Agricultural College — today's Clemson University.

As the Centennial theme, "Tradition and Vision," suggests, Clemson is using the occasion of its Centennial not so much to celebrate the past as to contemplate the future. The University is determined to make its second century even better than its first. To that end, Clemson faculty, staff, students and alumni scored significant successes in 1987-88 in each of the five areas of emphasis identified as focal points in the University's strategic plan for achieving academic excellence with relevance. The plan is called "Clemson University: The Second Century." The five emphasis areas are agriculture and food, engineering and basic science, marketing and management, quality of life, and textiles.

This document details those successes through reports from the University's various academic and administrative units. It also details Clemson's unprecedented success in private support, which topped a record \$10 million for the year, and the continuing excellence of Clemson students. To show how all these programs and activities fit into the "Second Century" plan, the following highlights are presented as just a few examples of the many accomplishments of Clemson people during the year.

Agriculture and Food

- S.C. Agricultural Experiment Station scientists are field testing a biotechnology tracking system, developed by Monsanto, to determine if genetically engineered microorganisms can be effectively monitored in the environment.
- A four-year plan developed with advice from more than 5,000 citizens is helping the Clemson Extension Service focus on the problems considered most pressing by South Carolinians.
- A new catfish farm in Hampton County that will serve as a training and demonstration facility reflects Clemson's increasing efforts to boost development of South Carolina's growing aquaculture industry.

Engineering and Basic Science

- The S.C. Bioengineering Alliance — composed of Clemson, the University of South Carolina and the Medical University of South Carolina — announced in March 1988 the development of ORTHO-PERT, a revolutionary computer process for making customized joint implants. The project, funded in part by the S.C. Legislature, could produce significant patent income for the state.

- A new \$2 million "clean room" set up during the year will permit Clemson electrical and computer engineering students to learn about integrated circuits through hands-on experience and will support bioengineering and materials research. The facility was funded principally by the S.C. Legislature.
- The College of Engineering's new Program for Engineering Enrichment and Retention (PEER) expands Clemson's efforts to attract and keep black students. PEER matches each black freshman engineering major with a black junior, senior or graduate student "mentor" who gives advice and encouragement throughout the first year.

Marketing and Management

- Management students and researchers at Clemson are exploring practical applications of artificial intelligence in the business world and in business schools in an "expert systems" laboratory sponsored by IBM. The company in fall '87 awarded the Management Department its largest research package ever: contracts and equipment valued at \$705,000.
- Clemson management faculty continue to develop programs that give students experience in real-world decision-making. Faculty members have developed computer-simulated manufacturing plants that expose students to both make-to-stock and make-to-order product manufacturing.
- The worldwide marketplace is the focus of Clemson's new Language and International Trade Program, which has attracted 177 majors since it began in fall '87.

Quality of Life

- Clemson is the headquarters for a major education initiative announced in November '87 by Gov. Carroll Campbell. Project REACH — the Rural Education Alliance for Collaborative Humanities — unites 11 institutions of higher education and 10 public school districts in an effort to improve literacy levels through use of the humanities. The project is funded by a \$175,000 grant from the Rockefeller Foundation and allocations from the Governor's Office and the S.C. Committee for the Humanities.
- The Strom Thurmond Institute at Clemson completed its fourth year of work on the development of a water use policy for South Carolina. The project, entitled "The Situation and Outlook for Water Resources Use in South Carolina, with Projections to the Year 2000," is funded by the S.C. Water Resources Commission.
- The National Dropout Prevention Center at Clemson is moving full speed ahead with its efforts to cut the high school dropout rate. In its first two years, the center has established the S.C. Dropout Prevention Network and published a national directory of dropout prevention programs. As the 1987-88 fiscal year drew to a close, Dr. Jay Smink became the center's permanent director, and the General Assembly invested \$500,000 in the center for 1988-89.

Textiles

- 1987-88 was a year of preparation for Clemson's new Apparel Advanced Manufacturing Technology Demonstration Center, the centerpiece of a \$3.5-million,

three-year research project funded by the U.S. Army's Defense Logistics Agency. The research agreement, announced in September '87, is the largest in Clemson's history and could be extended to up to 10 years, with a total potential value of \$10 million.

- A new dimension in industry-university cooperation is emerging with the development of CUTREC, the Clemson University Textile Research Center. After a yearlong study, a prospectus for putting the center into operation was presented to the National Science Foundation this fall.
- Aggressive recruiting is helping to attract a growing number of students to Clemson's textiles programs. The School of Textiles received 120 applications from incoming students for fall '88, yielding the highest number of new textiles majors in 30 years.

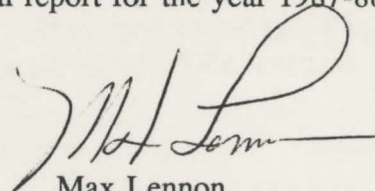
Students

- A record 2,818 freshmen enrolled for the 1987 academic year. Of those, 33 percent ranked in the top 10 percent of their high school classes, 63 percent were in the top 20 percent, and 93 percent were in the top 50 percent.
- Clemson's Graduate School experienced record numbers of applicants (2,709), new students (878) and total enrollees (2,902) in 1987-88. A new graduate program, the Master of Science in Applied Psychology, was approved by the S.C. Commission on Higher Education to begin in fall 1988.
- Clemson student-athletes in 1987-88 hosted and won the National Collegiate Athletic Association's soccer tournament, were victorious in the Citrus Bowl football contest with Penn State, and won Atlantic Coast Conference championships in football, golf, men's cross country, men's tennis and women's swimming. A total of 19 students were Athletic All-Americans.

Private Support

- Private gifts for Clemson's academic programs jumped a phenomenal 40.2 percent in 1987-88, reaching \$10.3 million and crossing into double digits for the first time in history.
- Unrestricted giving to the annual Clemson Loyalty Fund topped \$1 million for the first time ever.
- The year included announcements of major commitments, gifts and bequests that will lead to the establishment or significant enhancement of two Trustees Chairs, two Chairs, the library endowment, a Distinguished Professorship and two Presidential Scholars Endowments.

I am pleased to present Clemson University's annual report for the year 1987-88.



Max Lennon
President

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1987-88 UNIVERSITY BOARD OF TRUSTEES

Louis P. Batson, Jr., Chairman	Greenville
Billy L. Amick	Batesburg
James E. Bostic, Jr.	Aiken
Fletcher C. Derrick, Jr.	Charleston
W. G. DesChamps	Bishopville
William N. Geiger, Jr.	Columbia
Paul W. McAlister	Laurens
Thomas B. McTeer, Jr., Vice-Chairman	Columbia
Buck Mickel	Greenville
James C. Self	Greenwood
B. Marion Smith	Columbia
James M. Waddell, Jr.	Beaufort

Trustees Emeriti

Paul Quattlebaum, Jr.	Charleston
D. Leslie Tindal	Pinewood

Note: The terms of James E. Bostic, Jr., and William N. Geiger, Jr., expired June 30, 1988. John J. Britton, Louis B. Lynn and Allen P. Wood were elected by the General Assembly for terms beginning July 1, 1988.

ADMINISTRATIVE OFFICERS

Executive

Max Lennon, Ph.D.	President
W. David Maxwell, Ph.D.	Provost and Vice President for Academic Affairs
David R. Larson, MBA	Vice President for Business and Finance
Gary A. Ransdell, Ph.D.	Vice President for Institutional Advancement
Hugh J. Clausen, J.D.	Vice President for Administration and Secretary of the Board of Trustees
Manning N. Lomax, B.S.	Vice President for Student Affairs and Dean of Students

Academic

W. David Maxwell, Ph.D.	Provost
Milton B. Wise, Ph.D.	Vice President and Vice Provost for Agriculture and Natural Resources
Jerome V. Reel, Jr., Ph.D.	Vice Provost and Dean of Undergraduate Studies

Arnold E. Schwartz, Ph.D.	Vice Provost and Dean of the Graduate School
Christopher J. Duckenfield, Ph.D.	Vice Provost for Computer and Information Technology
Joseph F. Boykin, Jr., M.S.	Director of Libraries
Horace W. Fleming, Ph.D.	Director of the Strom Thurmond Institute for Government and Public Affairs
Stanley G. Nicholas, B.S. ¹	Director of University Research
Stephen R. Chapman, Ph.D. ²	Dean and Director of Resident Instruction
James R. Fischer, Ph.D.	Dean, Agriculture Research and Director, S.C. Agricultural Experiment Station
Byron K. Webb, Ph.D.	Dean and Director, Cooperative Extension Service
James F. Barker, M.A.	Dean, College of Architecture
Ryan C. Amacher, Ph.D.	Dean, College of Commerce and Industry
James E. Matthews, Ed.D. ³	Dean, College of Education
J. Charles Jennett, Ph.D.	Dean, College of Engineering
Benton H. Box, D.F.	Dean, College of Forest and Recreation Resources
Robert A. Waller, Ph.D.	Dean, College of Liberal Arts
Opal Hipps, Ph.D.	Dean, College of Nursing
Bobby G. Wixson, Ph.D.	Dean, College of Sciences

Admissions and Registration

B.J. Skelton, Ph.D.	Assistant Vice President for Student Affairs and Dean of Admissions and Registration
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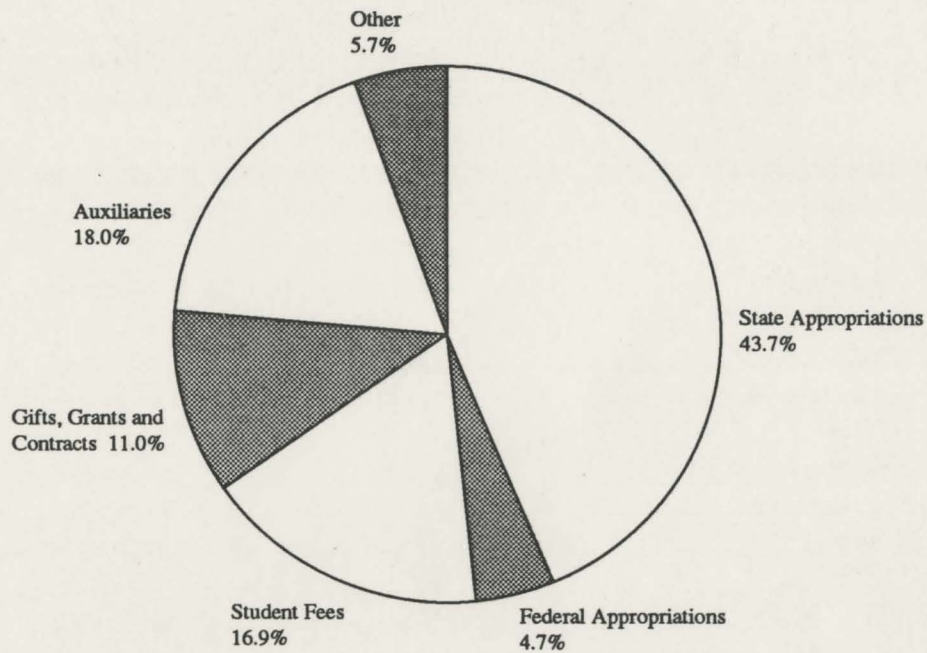
¹ Retired June 23, 1988. Succeeded July 1, 1988, by Jay Gogue, vice president for research.

² On sabbatical as of August 15, 1988. James H. Daniels serves as acting dean and director.

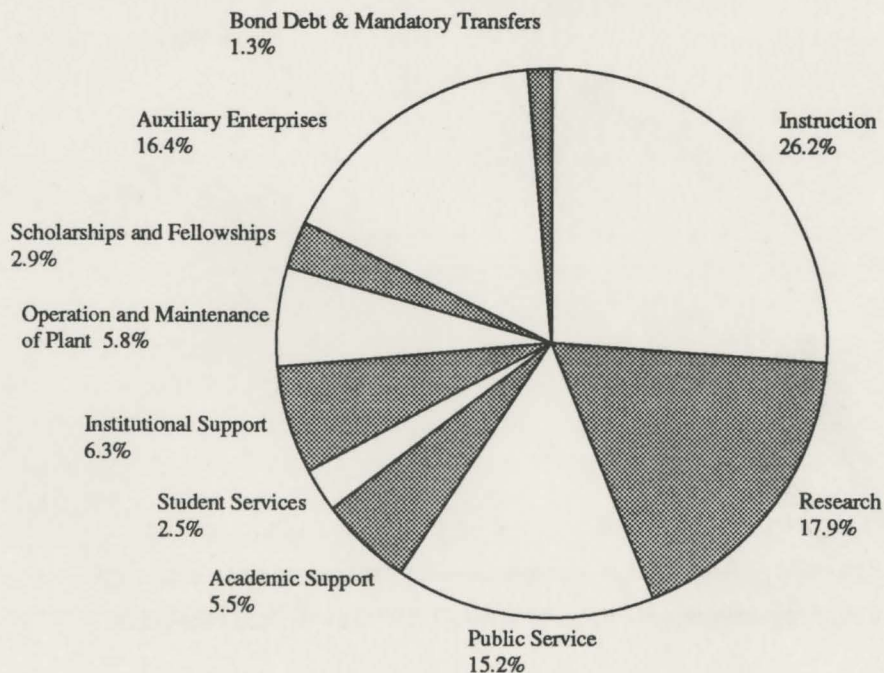
³ Returned to full-time teaching and research. Succeeded July 1, 1988, by Gordon Gray, dean.

CURRENT FUND REVENUES AND EXPENDITURES FOR THE YEAR ENDED JUNE 30, 1988

Current Fund Revenues



Current Fund Expenditures



COLLEGE OF AGRICULTURAL SCIENCES

The report of 1987-88 activities for the College of Agricultural Sciences' resident instruction, research and Extension programs is included under the Division of Agriculture and Natural Resources on page 62.

COLLEGE OF ARCHITECTURE

As Clemson University begins a Centennial celebration, the College of Architecture marks 29 years of service filled with innovation, experimentation and national leadership. The 1987-88 year proved to be very successful in building on this tradition.

In addition to the main campus in Clemson, the College of Architecture enjoys a graduate study center, the Charles E. Daniel Center for Building Research and Urban Studies in Genoa, Italy. This year the college added a third "campus": the Clemson University College of Architecture Center at the College of Charleston. This undergraduate center, located in the heart of the historic district of the city in the circa 1850 Cameron House, provides 18 junior and senior students each semester with the opportunity to live and study in one of America's finest cities and experience its treasure of architectural heritage and its unique sense of place. The Charleston Center is a remarkable example of a partnership in higher education between Clemson University and the College of Charleston. The addition of this third campus gives the College of Architecture a broad educational perspective and establishes the college as a national leader in educational opportunities for students and faculty.

The four professions of architecture, planning, building science and management, and visual arts and history were joined by an important fifth profession in 1987-88. Landscape architecture has long been a part of the dreams of the College of Architecture. South Carolina's first program in landscape architecture became a reality when freshman in the college were admitted to this program in fall 1987.

Two other degree programs began during the year. The Master of Building Science and Management admitted its first graduate students into one of America's only professional graduate programs to serve the country's largest industry, the construction industry. The Bachelor of Fine Arts, which also admitted freshmen in 1987, provides the foundation for the current Master of Fine Arts degree program. With this full visual arts curriculum at both the undergraduate and graduate levels, the Department of Visual Arts and History will serve as Clemson University's "Art Department" and in so doing will mark another step in Clemson University's maturing as a true comprehensive University.

The College of Architecture enjoys a tradition of excellence in teaching. This year three significant national awards added to this tradition. Alumni Professor Harold Cooledge was selected as one of five National Distinguished Professors by the Association of Collegiate Schools of Architecture. Professor Richard Norman received the American Institute of Architects Education Honors Award for his course in Computer

Graphics/Color Theory. This award was one of five chosen from a national field of 120 nominated courses. Professor Gayland Witherspoon was named a Fellow in the American Institute of Architects for his outstanding teaching and service to the profession. Professor Witherspoon joins four other Fellows of the American Institute of Architects on the College of Architecture faculty. This group represents over half the number of Fellows in the entire state of South Carolina.

The college revived an important tradition in its Distinguished Visiting Professors Program and selected Mr. Antoine Predock, a nationally prominent architect from New Mexico, as its visiting professor for 1987-88. Mr. Predock taught at the graduate and undergraduate levels on all three campuses: Clemson, Charleston and Genoa.

Perhaps the most significant activity in the college for 1987-88 was the implementation of an on-going planning process. Determined that this process would not result in a static plan, faculty, staff, students and the administration developed a dynamic plan which is both strategic and participatory. The plan has already proven to be an effective and meaningful tool for the management of change in the college.

The need for a new associate dean for development, public service, and research was identified through this planning process. Associate Dean Gayland Witherspoon will serve as the executive director of the Clemson Architectural Foundation and will further strengthen the tie between the Clemson Architectural Foundation and the Clemson University Foundation.

The plan further identified the need for a College Advisory Council, composed of all professions represented in the college, to advise on matters of curricula, programs, research, admissions and changes affecting these professions. This council held its first meeting during the spring semester and will meet semiannually.

Further, the plan identified the need for aggressive programs for faculty development. The administrative council has responded with several new initiatives for the development of faculty, including summer faculty, grants for study supported by University funds and individual faculty grants supported by Clemson Architectural Foundation funds. Other programs for faculty development are currently under study.

Finally, the plan identified a critical need for additional facilities and called for a two-phase program for improvements. The first phase is maximum utilization of our current facilities, including the creative use of space in Lee Hall. The second phase is the expansion of Lee Hall. It is clear that both phases will be needed if the new programs and expanding existing programs are to meet the standards of quality the college has worked 29 years to establish. The first phase of the program is under way with a study developed by a professional architectural firm.

If this planning process can continue to be a dynamic one, the college will develop an ability to respond to challenge and change. Three new department heads have been named during the past 14 months: Professor Jose Caban in the Department of Planning Studies, Dr. Roger Liska in the Department of Building Science and Management, and Professor John Jacques in the Department of Architectural Studies. These changes, coupled with the search for 12 new faculty positions, have provided the College of Architecture with the opportunity for meaningful growth. It is intended that these new faculty positions, all at the junior level, will provide the college with new energy and insight as we build on our tradition of academic excellence.

Special Programs

The Clemson Architectural Foundation Lecture Series, supported by donations to the Clemson Architectural Foundation, sponsored the following speakers for the academic year 1987-88: Charles Gwathmey, Robert Marvin, Edward Pinckney, James Barker, Leon Krier, Robert Dunay, Chris Risher, Matthew Rice, Bob Silverman, Philip Mullen, Aldo Rossi, Kenneth Frampton, John Margolies, Takefumi Aida, Antoine Predock and Harold Coolidge.

The Rudolph E. Lee Gallery is Clemson University's art gallery, and the following exhibitions were shown last year:

August 20 – September 9	Herb Jackson: "Recent Monoprints," CSCA Traveling Art Show
September 10 – 16	O'Dell Associates, Architectural Projects
September 21 – October 12	Architecture Design Faculty Exhibition
October 19 – November 16	Outer Banks to Infinity, "Landscape Photography"
November 18 – 21	Student-Faculty Art Sale
December 2 – 17	MFA Thesis Exhibition
January 6 – 25	Facts, Fables, Fantasies, Contemporary Narrative Art of the Southeast
February 8 – 29	Philip Mullen: Retrospective Exhibition, 1968-1987
March 7 – 25	MFA Thesis Exhibition
March 28 – April 7	Ireland G. Regnier: Retrospective Exhibition
April 11 – 18	Architectural Thesis Design Projects
April 25 – May 23	Student Honors Exhibition
June 13 – August 1	Summer Show of Student Work

Architectural Studies

The academic year 1987-88 proved to be a significant year for the Department of Architectural Studies. Professor Kenneth J. Russo resigned as head to resume the full-time teaching and practice of architecture. Professor Russo was named director of the Health Care Facilities Planning and Design Studio. After a seven-month national search evaluating over 50 candidates, Professor John J. Jacques was appointed as the new head of the department and assumed his duties August 1988.

Other significant faculty accomplishments for the year included:

- Professor Lynn G. Craig was elected director and member of the board of the South Carolina Chapter of the American Institute of Architects.
- Professor Martin Davis was awarded the rank of professor. He served as the editor of the college newsletter. He was elected to the State Board of Review — National Register of Historic Places, S.C. Department of Archives and History. In April 1988 Professor Davis' article, "An Evaluation of Traditional Architecture in Warm Humid Climates: The Charleston Single House," was published in *Traditional*

Dwellings and Settlements in a Comparative Perspective and was presented at an international symposium at the University of California at Berkeley.

- Professor Robert Hogan attended Cranbrook Teachers Academy in Bloomfield Hills, Mich., during the summer of 1988 and attended the University Professors Masonry Workshop in Boulder, Colo., in April 1988.
- Dr. Jane Hurt was awarded a Provost Research Grant to further her research on "The American School Building."
- Professor Dale Hutton served at the professor-in-residence at the CAF/Charles E. Daniel Center for Building Research and Urban Studies in Genoa, Italy, for the academic year 1987-88.
- Professor John Jacques was granted a semester's sabbatical to research "Cultural Anthropology and Practical Activity: Applying Theory and Practice to Teaching Basic Design."
- Professor Yuji Kishimoto organized and directed "Exploration in Architecture," a two-week architecture camp and an introduction to architecture for high school students. He also coordinated the Southern United States — Japan Architectural Exchange (SUJAE) program. In addition, he gave two lectures, "Light in Architecture," at the South Carolina Governor's School for the Arts and taught an introduction to architecture course to these gifted students.
- Professor Peter Lee, in addition to his role as director of graduate studies in the department, organized and directed the second annual graduate symposium "Memory in Architecture." Professor Lee also directed the annual Architect's Day events.
- Dean Emeritus Dr. Harlan E. McClure, FAIA, was named chairman of the Fort Hill Restoration Committee.
- Professor George C. Means, Jr., FAIA, was elected a member of the national AIA Committee on Architecture for Health. He also coordinated the public service project Centro Medico Del Turabo in Caquas, Puerto Rico.
- Professor Richard Norman attended the Cranbrook Teachers Academy in Bloomfield Hills, Mich., during the summer of 1988. His publications included: "Intuitive Design and Computation," a chapter in the book *The Computability of Design*, edited by Yehuda E. Kalay, Ph.D., and "Designing the Electronic Pedagogy," published in the proceedings of East Central, ACSA Regional Meeting, Kent State University.
- Professor George Polk was granted a sabbatical leave for academic year 1987-88 for research entitled "A Survey of Examples of Vernacular Architecture of the Upper Piedmont of South Carolina."
- Professor Gerald Walker served as the ACSA faculty counselor for the Department of Architectural Studies.
- Professor Joseph L. Young, FAIA, was selected as the first professor-in-residence of the Clemson University College of Architecture Center at the College of Charleston and received the national Tau Sigma Delta Silver Medal for Service.
- Professor Matthew Rice attended the Cranbrook Teachers Academy in Bloomfield Hills, Mich., during the summer of 1988. He also presented one of three papers in the graduate symposium "Memory in Architecture."

- Professor Ray Huff served as the resident professor at the new Clemson University College of Architecture Center at the College of Charleston.
- Professor and Dean James F. Barker was elected board member and director of the Southeast region of the Association of Collegiate Schools of Architecture. He served as Southeast regional coordinator of the National Endowment for the Arts, chairman of the Honor Awards Jury for the West Virginia Chapter of the American Institute of Architects, was appointed to the National Committee for Professional Conduct of the National Council of Architectural Registration Boards, and received the ACSA Citation for Service at the 1987 national meeting in Miami. His article "The Courthouse Square" was published in *Architecture California* in the January/February 1987 issue.
- Five architectural students were selected to receive national AIA scholarships, totaling \$9,000: David Loy, Doug Rackley, David Greer, Rachel Young and Chris Buchanan.
- The department hosted the first worldwide workshop on Air Force Architecture held in the College of Architecture during the summer of 1987.
- After an interim of several years, the faculty of the Department of Architectural Studies revived a tradition of exhibiting their work in the Rudolph E. Lee Gallery to publicly communicate their creative work in architectural design and technology.

Building Science and Management

The 1987-88 year was one of change for the Department of Building Science. On July 1, 1987, Roger W. Liska assumed the responsibilities of head, replacing Ralph E. Knowland after 25 years of service.

Significant faculty accomplishments for the year included:

- Professor Roger Liska was elected national vice president of the American Council for Construction Education. He had two publications during last year, a book entitled *Facilities Maintenance Standards*, published by Robert Snow Means in February 1988, and an article, "Indoor Air Pollution as an Issue in Planning Schools," in the *Journal for the Council of Educational Facilities Planners, International*. He also served as lecturer at moisture control seminars sponsored by the Clemson University Extension Service in Columbia; taught a one-day workshop on "Construction Planning and Scheduling" for the Southeastern Michigan Chapter of Associated Builders and Contractors in Naples, Fla.; conducted the American Council for Construction Education (ACCE) training sessions for prospective accreditation team visitors at the annual meetings of the Associated General Contractors of America; presented a paper, "An Overview of Construction Education and Training in the United States," at the annual meeting of the Canadian Home Builders Association of British Columbia; served on a panel at the annual meeting to discuss the current state of building education in Canada and the United States; and made a presentation, "Construction Management: What Is It and How Does One Get Involved?" at the Annual State Convention of the

- North Carolina Chapter of the American Institute of Architects in Charleston, S.C.
- Professor Liska received his Doctorate in Educational Administration from the University of Georgia in March 1988 and was inducted into Kappa Delta Pi National Honorary Education Society at the University.
 - Professor Francis Eubanks was granted the status of "Constructor" membership in the American Institute of Constructors at the September meeting of the South Carolina Piedmont Chapter, AIC. He presented a paper, "Construction Finance Modeling for Income Property," at the annual meeting of the Southeastern region of Associated Schools of Construction in Atlanta, Ga.
 - Professor Steve Schuette was elected director of the Southeastern region of the Associated Schools of Construction (AIC).
 - Professor David Egan presented a paper, "Design Vocabulary: Spaces for Music Performance," and chaired the session "Problems in Practice" at the Sixth Annual ACSA Technology Conference on "Technology is Design" at the San Francisco Art Institute. Professor Egan's book, *Architectural Acoustics*, was selected for the March 1988 Selection of Architects' Book Club.
 - Professor Anders J. Kaufmann presented a paper at the ACSA Technology Conference in San Francisco.
 - The department established one- and five-years goals. These goals were refined and became part of the college plan.
 - Plans were developed to offer the first Telecampus course in fall 1988 with CABS 865 Project Management being taught by Professor Liska.
 - The departments of Building Science and Civil Engineering began collaborating on the Construction Industry Cooperative Alliance, an alliance between member firms from the construction industry in the Southeastern region of the United States and the two departments at Clemson. The objective of CICA is to improve the productivity, profitability and effectiveness of all parties involved in the construction industry. To this end, CICA will promote dialogue, partnering, continuing professional development, technology advancement and communication among owners, architects, engineers and constructors. A database of Southeastern firms and CEO's has been established, and a mailing has been sent to invite participation.
 - A faculty search was begun in December 1987 and continued through the spring for two new faculty members. Forty-nine applications were received, eight applicants were interviewed and two positions have been filled on a one-year, non-tenured track basis.
 - During February and March, the department co-sponsored with the Associated Builders and Contractors two Supervisors Academies at the Clemson University Outdoor Laboratory. Thirty-two participants attended each academy. Professors Liska and Schuette taught in the academies, and departmental students and staff assisted. This effort was so successful that three more are planned for fall 1988 and three for spring 1989.
 - The department spearheaded an effort in the college to increase visibility of our programs to high school counselors. A database of high schools, principals and guidance counselors was established, a questionnaire was mailed, and subsequently, invitations were sent to guidance counselors in the state. The first Career

Day was held in the college March 1, 1988, and counselors attending represented over 1,500 high school students. It is anticipated that this will become an annual college event.

- The department successfully completed a fund-raising drive to purchase equipment for a materials testing lab.
- The department continued to maintain the S.C. State Contractors Licensing examinations during the year, revising four exams.
- A preliminary proposal was prepared with the Industrial Education Department at Clemson University regarding offering the Master of Building Science and Management degree with a concentration in the area of education.
- The department received a research grant from the Associated Builders and Contractors for the development of an Absenteeism and Job Turnover Program.

Planning Studies

Academic year 1987-88 began under the leadership of Department Head and Professor Jose R. Caban. The department successfully completed a period of reorganization and review. Three faculty members were appointed to fill vacant positions, bringing the number to five permanent faculty members. The new professors are Kerry Brooks from the University of Washington, Herbert Norman from Michigan State University and James London, who has been a member of the faculty as a visiting professor since 1985. Together, they add strength in the areas of environmental planning and geographic information systems, housing and preservation, regional economics and economic development.

Significant faculty accomplishments for the year included:

- The Planning Accreditation Board concluded its review of the Master of City and Regional Planning program with a campus visit in March 1988. The board, which meets in October 1988, will act upon the team's recommendation of full accreditation.
- Professors Jose Caban and Barry Nocks were promoted to the rank of professor.
- Professor Barry Nocks delivered a paper at the Association of Collegiate Schools of Planning Annual Conference in Los Angeles.
- Professor James London was invited to participate in an international conference on water resources held in Havana, Cuba.
- Visiting Professor Margaret Foster led a group of students in a study of the Calhoun Historic District, sponsored by the Clemson Chamber of Commerce and the Pendleton Historic Society. She continued her public service activities as an adviser to the Green Avenue Community Organization in Greenville, S.C. In the spring, Professor Foster guided a study tour of planning students to the Yucatan Peninsula in Mexico to visit the ruins of ancient cities.
- The department initiated a Visiting Professional Program during the year. Participants included: Dr. Mitchell Rycus, director, Planning Program, University of Michigan; Albert Medvitz, Boston University; Hasan Sanobara, University of Southern California; Bryan McGregor, University of Glasgow, Scotland; Mayor Bill Workman, Greenville, S.C.; and Margaret Davidson, director, S.C. Sea Grant Consortium.

Visual Arts and History

Under the leadership of Department Head John Acorn, the department received approval from the Commission on Higher Education for the Bachelor of Fine Arts degree program and admitted freshmen into this new program.

Other faculty accomplishments included:

- One of Professor Tom Dimond's paintings was selected for the South Carolina Art Collection.
- Professor Sydney Cross' exhibition "Southern Narrative: Fact, Fiction and Fantasy" was selected for a showing.
- Professor Jim Stockham's sculpture was exhibited in Cobb Gallery in Atlanta.
- Professor Mike Vatalaro was elected to the Board of Directors of the South Carolina Crafts Association. He also participated in one of "Five Ceramic Artists" exhibitions at Converse College.
- Dr. E. Cecilia Voelker was granted a sabbatical leave for academic year 1987-88 for research on quarantine stations of the Atlantic Seaboard.
- Professor John Acorn was elected to the Board of Directors of the Hambridge Center for Creative Arts and Sciences. He was also a visiting artist at the South Carolina Governor's School for the Arts.
- Professor Sam Wang completed a year-long sabbatical study of "Art Using Computer Graphics."
- Retirements for the department included Alumni Professor Harold N. Cooledge, Jr., and Professor Ireland Regnier.

COLLEGE OF COMMERCE AND INDUSTRY

Accountancy

The School of Accountancy graduated 103 B.S. students and 11 MPAcc students during the 1987-88 academic year. Of the B.S. graduates, 18.4 percent graduated with University or departmental honors. Placement statistics indicated that 24.3 percent of the B.S. students accepted positions with certified public accounting firms, 17.5 percent with national public accounting firms. All MPAcc students were placed with 91 percent accepting positions with national CPA firms. These statistics compare favorably with national averages. The number of firms recruiting accounting majors at Clemson continues to increase with significant placements occurring in the South Carolina, Georgia and North Carolina area. The School of Accountancy is recognized as a primary recruiting school for major accounting firms in this three-state area. Enrollments in the B.S. and MPAcc programs continue to increase with another record number anticipated for the 1988 fall semester. Performance on the CPA exam by Clemson students is improving slowly. Faculty will continue to address this area over the next several years.

Faculty research productivity continues at a strong pace. During the year, the faculty had six books and 25 journal articles published or accepted for publication, and

presented 17 papers at professional accounting meetings. They also presented numerous speeches and professional development courses.

In January 1988 the school received national recognition from the Institute of Internal Auditors, who chose it as the second school to receive financial support to establish a pilot school program in internal audit education. Under the direction of Professor G. Thomas Friedlob, who has been designated an IIA Research Fellow, the school received a grant of \$15,000 to initiate the program. The first course will be offered in the 1988 fall semester and already has a full complement of students enrolled.

Professor Joseph Louderback received the 1988 College of Commerce and Industry J. E. Sirrine Foundation Award for Excellence in Teaching, the second year in a row the award has gone to a School of Accountancy faculty member. In the professional service area, five members of the faculty serve on national committees of professional accounting organizations. Several continue to hold positions on the board of directors of local and regional accounting organizations and serve at the state level as well.

Economics

The Department of Economics stresses scholarly research, effective teaching and informative public service. The 23 full-time faculty members obtained their Ph.D. degrees from many of the best universities in the nation, bringing to Clemson a variety of teaching and research perspectives. This year faculty members published in 19 economics journals. Four of these, *The Journal of Political Economy*, *Journal of Law and Economics*, *Review of Economics and Statistics* and *Journal of Human Resources*, are among the best journals in the profession.

Published research is directed at important national policy issues: the acid rain debate, academics versus athletics, military wages, regional development, unemployment insurance and survivorship in the banking industry.

Ongoing research is directed at topics such as sexual discrimination in the workplace, academic governance, market approaches to environmental regulation, the impact of regulation on energy supplies and air traffic safety, as well as areas of pure economic theory. Both the recently published and ongoing research have received attention in the popular press. This year faculty were recognized in *The Wall Street Journal*, *New York Times*, *Fortune*, *Forbes*, *Washington Post*, *American Banker* and *Aviation Week*.

The department received grants of more than \$100,000 this year to support research, including a continuing grant of \$10,000 from the DuPont Company for environmental economics research. The department works closely with the Center for Policy Studies to disseminate this research to the widest possible audience.

A grant from the DuPont Company allowed the department to sponsor, in conjunction with the Center for Policy Studies, a seminar series for distinguished scholars. Scholars from the University of Chicago, Texas A & M University, the Federal Reserve Board and other noted institutions participated.

Five master's students and one Ph.D. student completed requirements for their degrees this year. All accepted positions in government and business. Our first Ph.D. student has accepted a position with the Securities and Trade Commission in the Office of Chief Economist.

The department completed a proposal to begin a new economics journal tentatively entitled the *Journal of Industrial Economics*. Several publishers have expressed strong interest. This journal will provide an exciting new outlet for economic research and will fully exploit the expertise of our faculty.

Finance

The Department of Finance's teaching load was again one of the highest in the University during the past year as the number of finance majors continued to grow. This increase led to the addition of one faculty member for next year and plans for additional faculty in the near future.

Faculty research emphasis this past year was on helping the department exceed AACSB accreditation standards for research. Professor Sirmans continues to lead the department's research effort with five refereed publications. The variety of research subjects investigated by the faculty included creative debt financing and municipal bonds, valuation of VA assumable loans, income property valuation, an analysis of IRAs, how expenditure taxes affect saving incentives, how insider "nontrading" can be inefficient, leveraged buyouts in the textile industry, how specialized assets and government regulation interact to affect organizational structure in the natural gas industry, and an analysis of how effectively the diverse kinds of price and interest rate indices in mortgage contracts cope with volatile interest rates. These articles were published in such journals as *The Journal of Real Estate Research*, *The Journal of Finance*, *The Financial Review*, *Southern Economic Journal*, and *Quarterly Journal of Business and Economics*.

Several financial companies and institutions, including NCNB and First Union of South Carolina, supported student scholarships during the year. Thomas C. "Buck" Breazeale contributed \$5,000 for faculty research projects.

Management

The Department of Management continues to lead the integration of information technology and industrial management. The three laboratories described below provide capabilities for research and teaching found in no other business school in this country.

During the year the department signed the largest research contract in its history. A contract valued at \$705,000 was signed with the IBM Corporation for research and teaching concerning the applications of expert systems in business schools. As a result, an Expert Systems Laboratory equipped with an IBM 4341 mainframe computer and Expert Systems Environment software was established. To our knowledge, the laboratory is the only one of its kind concerning the application of artificial intelligence techniques in business schools.

The Jobscope Corporation granted \$40,000 worth of software for the Hewlett-Packard Manufacturing Management Lab. Teaching and research in that lab will concern the integration of information technology and manufacturing management in a make-to-order manufacturing environment.

Teaching and research continues in the award-winning IBM Manufacturing-Management Lab. That lab stresses the integration of information technology and manufacturing management in a make-to-inventory environment.

To further develop its teaching and research programs, seven new faculty were hired for fall 1988.

Marketing

The B.S. degree in marketing is the newest degree program in the College of Commerce and Industry. The 1987-88 academic year saw 37 students receive their degrees in marketing. This number is expected to increase rapidly since more than 450 students have elected to major in marketing. Students have transferred into marketing from majors across the campus, and many incoming freshmen have chosen marketing as their major.

Two new tenure-track faculty members have been added to the department bringing the total full-time faculty to nine. One of our faculty members has recently returned from a year's sabbatical in which he participated in a Fulbright Fellowship in Turkey. Another has received a second year of funding for a research project to gain insight into improving retention rates for minority students at Clemson University.

A number of marketing classes received significant publicity this past year for research projects performed for the business community. Several business owners came to hear student presentations on improving marketing practices in their companies. In cooperation with the Emerging Technology Development and Marketing Center, one class received special recognition for assistance with research on identifying markets for membrane technology.

Textiles

The School of Textiles completed its most successful year in the area of funded research. Two projects are notable. The Defense Logistics Agency awarded the School of Textiles the largest research contract in the history of Clemson University. The project, led by Christine Jarvis, is to build and staff a demonstration sewing factory at Clemson. The five-year contract is worth between \$5 million and \$10 million. The second project was a planning grant from the National Science Foundation to create a Textile Research Center at Clemson. Professors Whitley and Ellison are leading this project.

We are anticipating the largest freshman class in textiles in over two decades due to an aggressive recruiting effort in 1987-88.

Professional Development

More than 18,000 people looked to the College of Commerce and Industry in 1987-88 for continuing professional education giving the Office of Professional Development the most successful year in its 30-year history.

A stable economy, despite the October stock market crash, created enough market opportunity for PD to post its biggest numbers ever in public and in-plant seminar offerings — 861 and 171, respectively.

Successes in the four major product lines — textiles, management, computer competency and in-house — also gave rise to PD's most successful financial year ever.

With the textile industry enjoying a highly productive year, PD conference and workshop attendance flourished. There was increased participation from newly hired employees in such courses as Fundamentals of Textiles, Slashing, Carpet Manufacturing, and Carding and Sliver. In all, some 3,000 managers benefited from the wide selection of textile events developed and implemented under the guidance of Assistant Director Jud Hair. Topics which range in subject matter from basic processes and techniques to the latest in technological advancement were featured.

Just-In-Time and Quick Response continued to be popular as two implementation workshops and one broad-based conference attracted more than 100 attendees. Additionally, a new nine-hour, five-tape video workshop was produced to help textile companies conveniently and economically introduce their entire staffs to the critical concepts behind JIT/QR.

Electronics in Textiles, a co-sponsored effort with N.C. State University featuring an appealing combination of technical sessions and equipment exhibits, had the best turnout in its nine-year history. More than 200 participants, speakers and exhibitors were on hand for the event in Greenville, SC, in March.

In the management arena, an ambitious effort to bring the highly successful one-day Professional Development for Women conference to more cities than ever before bore much fruit. PD Assistant Director Helena Douglas spearheaded the drive to produce eight conferences (twice as many as in any previous year), which attracted 1,412 participants interested in the finer techniques of negotiating, delegating, financial planning, managing conflict and much more. Richmond, Va., and Washington, D.C., provided the highest enrollments at 240 and 236 attendees, respectively, and Atlanta captured the third highest total at 192. The remaining cities were Charleston, Greensboro, Orlando, Jacksonville and Wilmington, DE.

Meanwhile, Associate Dean and PD Director Ralph Elliott began attracting overflow audiences to his seminar on Increasing Registrations and Revenue Through Effective Seminar Conference Marketing. In Washington, D.C., for instance, 46 people signed up for an early June '88 session, forcing PD to open another in August. At the time of this writing, it already had attracted 27 participants. San Francisco, Atlanta and Chicago sessions rounded out the year.

In computer competency, enrollment climbed to an all-time high of almost 9,000 participants as Assistant Director Conrad Stuntz increased the size of the promotional catalog and created numerous specialty brochures to help service the growing demand in Clemson's chosen market area — South Carolina, North Carolina, Georgia, Florida, Alabama, Virginia, Maryland, Washington, D.C., Kentucky and Ohio.

And a new course — Using Lotus 1-2-3 for Effective Business Applications — made inroads into low-end competition and enjoyed immediate success with its strategy of reaching the smaller populations of South Carolina, North Carolina, Florida, Georgia and Alabama.

On-site training, very much a by-product of the public offerings, also continued to boom, serving a record 3,633 participants in 171 separate sessions. Customized training continues to be developed for such notable organizations as Westinghouse, Santee Cooper, Sonoco, Milliken, the CIA, the Federal Law Enforcement Training Center, Merck, Sharp & Dohme, the Home Mission Board and the U.S. Justice Department.

Also, the in-house training effort continues to maintain its international flavor. Again this year the British textile company Courtaulds sent 24 of its top managers to Clemson for two rigorous weeks of executive training. In addition, the Jordon Institute of Management interned one of its managers in Clemson for two weeks to learn about continuing education development and marketing. And five Egyptian textile managers, contracted through the Agency for International Development, arrived in Clemson for six months of textile training.

Small Business Development Center

The Clemson University Small Business Development Center, with satellite offices located at Spartanburg Technical College, Greenville Technical College and Lander College, continued to deliver quality business and technical assistance to the 11 northwestern counties of South Carolina. The Small Business Administration and the Control Center will exceed their goals of assisting 540 small business clients and providing 19 management training programs.

The Clemson Basic Service Center has continued efforts in the research area. A Research Findings of Small Business Needs Assessment has been completed and printed. This report includes business management information, educational needs assessment and respondent information. This management tool is valuable as we plan and deliver business management, technical assistance and educational needs to our clients.

The center administers a Defense Logistics Agency grant for the establishment of a federal procurement program for small businesses. This program is in the second year of operation, and we anticipate several procurement contracts will be awarded to small businesses in our service area.

Beyond establishing and maintaining this foundation of deliverables, the Small Business Development Center has voluntarily expanded its role on campus. It promotes funding from sources other than federal and state governments to initiate programs that support Clemson University's Second Century Plan for rural economic development and an Emerging Technology Development and Marketing Center. An example is the recent notification by the W. K. Kellogg Foundation that a \$1.1 million grant has been awarded to Clemson University to develop a program to revitalize small rural communities through local leadership development.

COLLEGE OF EDUCATION

During the first year of the Clemson Centennial Celebration, the College of Education paused to reflect with pride on the quality programs it has offered for teachers and school personnel since 1916, to renew its commitment to excellence in the teacher education field, and to prepare for a major role in Clemson's Second Century.

Dr. James E. Matthews completed his term as dean of the College of Education and returned to teaching on June 30. Dr. Gordon W. Gray, a member of the college faculty for the past 20 years, has been selected to replace Dr. Matthews as dean, effective July 1, 1988.

The year was highlighted by the successful upgrading of several College of Education programs to meet the rigorous new standards of state and national accreditation agencies. The intensive internal review and curriculum modification program started in 1986 continued throughout the past year. Computer courses were added to teacher education curricula, and additional labs and advanced courses were added to programs for science teachers.

The college has now successfully met all preconditions of the National Council for the Accreditation of Teacher Education (NCATE) and will be visited by an NCATE Board of Examiners in October.

The South Carolina Education Improvement Act has focused attention on teaching as a profession and has resulted in numerous research and service programs aimed at attracting the state's brightest students to teaching careers, improving the quality of graduates entering the teaching profession, and expanding the opportunities and enhancing the capabilities of those already in the profession.

Clemson's College of Education plans to continue to play a leadership role in furthering educational improvement initiatives under way in South Carolina.

Instruction

As one of four institutions in South Carolina with nationally accredited teacher education programs at the undergraduate and graduate levels, Clemson's College of Education offers a variety of programs designed to prepare students to meet the growing demand for competent teachers and professional service personnel for schools from the kindergarten through the university levels. The college is the state's major producer of math, science and vocational/ industrial technology teachers.

The college also offers an excellent graphic communications program, which prepares students for professional careers in printing/publishing/packaging industries.

Clemson's teacher preparation programs have long stressed in-depth study in subjects to be taught and extensive practical experience in the laboratory and in the field. In effect, secondary education students receive a double major — the subject and education. A concentration of subject area study also is required by the elementary education program. Thus, a major portion of the rigorous teacher preparation curricula is taught by Clemson's faculty in other colleges.

During the past year approximately 1,600 placements were made in our laboratory-

centered teacher preparation programs. Placements ranged from full-day, 12-week student teaching to the tutoring of individual children.

The Learning Resource Management Lab operated on a 12-hour daily schedule to help students upgrade their basic skills. The program served approximately 150 students per week. Graduate and undergraduate classes also used this laboratory for hands-on instruction in the educational applications of computers.

Funding for the South Carolina Center of Excellence in Math and Science Education — a joint project of the College of Education and the College of Sciences — was renewed by the State Commission on Higher Education. The project is designed to increase the number of public school teachers certified to teach math and science and to upgrade the skills of in-service teachers in these disciplines.

The United States Department of Education renewed its grant to prepare special education teachers to work with handicapped students in public schools at the secondary level.

The Department of Industrial Education provided instructional programs for more than 350 majors in the bachelor's, master's and doctoral degree programs during 1987-88. Utilizing the newly renovated laboratories in Godfrey Hall, 14 faculty members provided students with hands-on learning experiences in all of the technical areas. The central theme for all programs in the department is "technological literacy." In the long-range plan to equip all laboratories with the latest technology in instructional systems, four areas were updated during the past year. The drafting lab added computer aided drafting (CAD); the power technology lab added robotics and computer controlled operations; computer aided machining (CAM) was added to the machining course; and the graphic communications lab added new plate-making, flexo and screen printing equipment.

In-Service

Clemson is a leader among South Carolina institutions in providing support services for local school districts, teacher organizations, teachers, administrators and industries. Graduate classes are offered on an evening schedule to accommodate the needs of teachers and administrators employed in nearby schools. In addition, a number of special institute courses for graduate credit are designed and taught in off-campus locations to meet unique needs of school districts.

During 1987-88 the College of Education offered 155 off-campus courses at 28 locations throughout the state for 2,275 students. Of the 155 off-campus courses, 95 were regular Clemson University courses offered at 15 different locations for 1,152 students. In addition to the regular courses, 60 contract courses were held at 20 sites and enrolled another 1,123 students. The 60 contract courses included 37 courses funded by the State Department of Education as Critical Teacher Needs courses in the teaching areas of mathematics, reading, sciences and computer education for 690 students. This represents an increase over 1986-87 of some 372 students and 39 additional courses.

The Department of Industrial Education continued to offer off-campus courses for teachers and personnel in industry. Several faculty members conducted continuing

education non-credit seminars, workshops and industrial training sessions as well as courses for graduate credit offered as public service activities throughout the state. More than 300 vocational education teachers enrolled in courses taught off campus during the year.

Research and Grants

In addition to the Center for Excellence in Math and Science Education and the secondary special education grants mentioned previously, the South Carolina Department of Education also renewed its grant to Clemson, in conjunction with The Citadel, Francis Marion College, Furman University, South Carolina State College, The University of South Carolina and Winthrop College, to support training and technical assistance centers to improve the leadership skills of prospective and practicing school administrators. It is known as the L.E.A.D. (Leadership in Educational Administration Development) project. Last year Clemson conducted research with practicing school administrators to determine leadership styles and their use. This summer an Administrators Leadership Conference was held, and additional seminars will be offered during the year to school personnel focusing on effective school research practices.

The Elementary and Secondary Education Department received a grant from the South Carolina Department of Education to develop a program to prepare teachers of infants and preschoolers with handicaps. The Department of Industrial Education received \$30,000 in several small grants from the State Department of Education to support the on-going retraining of teachers in industrial technology education, principles of technology, applied vocational mathematics and vocational education.

The State Department of Education also provided a \$60,574 grant to continue the trade and industrial teacher education program offered throughout South Carolina. This grant provided for the preparation of new teachers for vocational subjects through the cooperative efforts of the Office of Vocational Education and the Department of Industrial Education.

A variety of other research activities were also pursued, from mother-infant interaction patterns and their impact on learning to the impact of teacher incentives.

Special Activities and Services

Last year the College of Education provided a variety of services to students, the South Carolina Department of Education, school districts and teachers continuing their education. For example:

- Special institute graduate courses on the educational applications of computers were taught in several school districts.
- The annual Clemson Reading Conference provided an opportunity for reading and elementary teachers to hear national leaders discuss ways to improve reading instruction in the schools.
- The Clemson Writing Project, a joint venture of the College of Education, the College of Liberal Arts, and several nearby school districts, worked with classroom teachers to help teach writing in the public schools.

- The Department of Industrial Education provided industrial training to more than 200 persons from the printing and related industries and conducted special institutes and industrial technology education workshops in locations throughout South Carolina for in-service teachers.
- The Office of Educational Services and Placement held the first annual CUTIP (Clemson University Teacher Interview Program) in March 1988. Eighty-seven school personnel representing 57 school districts from Maryland, Virginia, North Carolina, South Carolina and Georgia participated. Sixty-two interviewers conducted approximately 600 interviews with Clemson teacher candidates during the two-day program. In addition to CUTIP, 10 school district personnel representing six school districts conducted 124 other interviews during the spring semester.

Through this variety of programs, Clemson has attempted to expand the opportunities for public school teachers and students throughout the state and the region.

COLLEGE OF ENGINEERING

The College of Engineering made remarkable progress during fiscal year 1987-88. The year began with a \$350,000 budget deficit and a shortage of six faculty positions. However, despite these problems, the college finished 1987-88 in record form with respect to gifts, research and faculty productivity. The college is fortunate to have a faculty with a solid commitment to excellence in both teaching and research. This commitment enables us to meet the challenge of providing today's technically sophisticated marketplace with increasing numbers of qualified engineering graduates. The economy of South Carolina is enhanced by industries that locate here. Providing the marketplace with well-trained engineers to attract and work in these industries is a major contribution of Clemson University.

In the past decade, enrollment in engineering programs has doubled and research has tripled. Yet, the availability of permanent working space has not increased to meet the demands of an expanding program. This year, allocation of space for engineering in Hardin and Brackett halls has been of significant help for the short term. Fortunately, the 1988-89 South Carolina Legislative Bond contains architectural and engineering planning funds for the Engineering Innovation Center. We believe that Clemson has one of the finest hands-on engineering programs in the country. However, more building space is vital to accommodate new computer resources, research facilities and classrooms.

Clemson's College of Engineering continues to serve the state and the nation by offering exceptional educational opportunities for students and by promoting research and development of new technological advances through the efforts of faculty and students. With our innovative programs and dedicated faculty and staff, Clemson engineering remains at the forefront of technological teaching and research at the close

of fiscal year 1987-88. As you will see in this report, the many and varied accomplishments of our faculty and students during this past year attest to our success as a major center of higher learning and research.

We continue to attract some of the best students in the state and nation at both the undergraduate and graduate levels. For the 1987-88 year, 1,071 University-managed scholarships were awarded — 455, or 42 percent, to students in the College of Engineering. For the 1988-89 academic year, 12 R. F. Poole Scholarship offers were made to incoming freshmen, eight of the 12 choosing freshman engineering as a major. The Poole Scholarships are the most prestigious awards given to students entering Clemson; they carry a renewable stipend of \$4,000 and an out-of-state tuition waiver. Undergraduate SAT scores continue to be high, and our engineers scored well above average on the Engineer-in-Training (Fundamentals of Engineering) Exam.

The College of Engineering continued to set records for private gifts and grants received during fiscal year 1987-88; a partial listing of these follows. Dr. Art Young was hired to fill the Bob Campbell Chair in Technical Communications in the fall of 1987. The Campbell Chair, which is administered jointly by the College of Liberal Arts and by the College of Engineering, is part of Clemson's effort to improve the communication skills of students in technical majors. This chair, the gift of Bob (Class of '37) and Betsy Campbell of Gaffney, is the first of its kind in the United States. The Campbells gave to the University stock valued at \$1.05 million in fiscal year 1985-86. In 1987-88, Bob and Betsy Campbell gave \$32,000 to match industry contributions for lab equipment for the technical communications program.

Through a deferred gift of \$1 million from alumnus Thomas M. Hunter (Class of 1909), the Hunter Endowed Chair in Bioengineering has been established, and applications from a number of leading scientists and scholars in the field have been received for this faculty position. The chair, endowed by Hunter's generous bequest, is named for his brother, Joe Everett ("Little Joe") Hunter, an 1896 Clemson graduate who taught mathematics here from 1901-1947. Tom's widow, Page, has generously contributed an additional \$125,000 to the Hunter Chair, as well as some \$100,000 toward the University's fund drive to build a biomedical and bioengineering research facility.

A \$700,000 gift and \$1 million bequest from Paul W. McAlister and members of his family will fund the P.W. and Bobbie McAlister Trustees Chair in Advanced Engineering Materials. A trustees chair is Clemson's most prestigious faculty appointment, requiring an endowment of at least \$1.5 million. McAlister, a 1941 Clemson graduate, is a life member of the Clemson Board of Trustees and was the first Clemson alumnus to serve as chairman of the Board (1975-1981). The Chair will be located in the Department of Ceramic Engineering, although the field of advanced engineering materials involves many disciplines, including textiles.

George J. Bishop III, founder of Waccamaw Pottery and 1952 Clemson graduate, initiated a \$650,000 gift to the Ceramic Engineering Department. Bishop and his family gave \$370,000, and the balance came from friends and business associates. This gift will endow the George J. Bishop III Distinguished Professorship in Ceramic Engineering.

Alumnus Milton W. Holcombe (Class of 1953) and his wife, Betty, endowed the Milton W. Holcombe Chair in the Electrical and Computer Engineering Department.

Holcombe, the co-founder and vice president of Electrospace Systems, Inc., a corporation based in Richardson, Tex., serves on the advisory board of the Electrical and Computer Engineering Department. Holcombe is a native of Central, S.C.

Also in the Department of Electrical and Computer Engineering, the D. Houser Banks Professorship in Microelectronics has been established. Banks was a 1916 Clemson graduate. Sherwood E. Liles Jr. (Class of 1927), retired president and chairman of Tidewater Construction Company, has committed \$500,000 to endow the S.E. Liles Jr. Distinguished Professorship in Construction Engineering.

Another professorship has been initiated by an industrial source. Dow Chemical Company will pledge \$20,000 or more per year for at least the next five years to develop a fund to support a titled professorship, which will be named the Dow Chemical Professorship in Chemical Engineering.

The College of Engineering has undergone some faculty and administrative personnel changes. Dr. William F. Beckwith, professor of chemical engineering, has accepted a position in the Freshman Engineering Program, effective May 15, 1988. Dr. Peter R. Sparks, professor of civil engineering and engineering mechanics, will be on sabbatical leave August 15, 1988, through May 15, 1989, to develop a coastal hazards advisory and mitigation program for the South Carolina Sea Grant Consortium. Dr. Dennis Dinger accepted a position on the ceramic engineering faculty starting August 1988. Dr. Dinger will contribute to the department's effort to establish national prominence in ceramic materials processing. His special interest is in investigating the effects of powder particle size distributions on particle packing and ceramic processing operations. Also, Dr. John W. Silvestro, assistant professor of electrical and computer engineering, joined the college in January 1988. Dr. Silvestro was formerly employed by the Electro Science Laboratory in Columbus, Oh., where he was a senior research associate working on electromagnetic code development. He holds B.S., M.S. and Ph.D degrees from Case Western Reserve University.

Dr. A. Wayne Bennett, professor and head of electrical and computer engineering, has been named interim associate dean for research and external affairs for the College of Engineering. Dr. Bennett began his new duties in July 1988. In his new position, Dr. Bennett will oversee research, development and public information in the college. He will develop new programs that will merge industry and alumni in the life of the college more effectively, while expanding research and development efforts. Dr. Bennett succeeds Dr. R. H. Brown, head and professor of civil engineering, who served as interim associate dean this past year.

As part of its mission, the College of Engineering continues to develop and participate in many public service activities. A summary of Continuing Engineering Education activities is in the "Public Service" section of this report.

Faculty and Student Honors and Awards

Faculty

Faculty members in the College of Engineering have received a number of awards for exceptional teaching, research and service in their individual areas of expertise.

These awards are indicative of our faculty's dedication to quality education and an enriched learning environment for students.

- Dr. Donald E. Beasley, associate professor of mechanical engineering, received one of five national 1988 New Engineering Educator Excellence Awards from the American Society for Engineering Education (ASEE). This award recognizes outstanding performance in undergraduate teaching and industrial research by a new engineering educator.
- Dr. A. Wayne Bennett, professor and head of electrical and computer engineering, was presented a meritorious achievement award for contributions to the Southeastern Center for Electrical Engineering Education (SCEEE). Dr. Bennett also was awarded a plaque during the Fourth Annual National Electrical Engineering Department Heads Association (NEEDHA) Planning Conference held March 6-8, 1988, in Orlando, Fla. This award was in honor of his outstanding service to the association. Dr. Bennett served as vice-chairman of the association and became chairman for 1988-89 in June.
- Dr. Marvin W. Dixon, professor of mechanical engineering, received the 1988 Engineering Educator of the Year Award from the Piedmont Chapter of the South Carolina Society of Professional Engineers. This award recognizes distinguished contributions to engineering education, especially in the classroom.
- Dr. Dan D. Edie, professor of chemical engineering, was given the Education Award of the Society of Plastics Engineers for his contributions to the education of students in the field of polymers and plastics. Dr. Edie also was sponsored by the United Nations on a month-long visit as a research scholar at Chungnam University in Taejon, Korea.
- Dr. James G. Goree, professor of mechanical engineering and engineering mechanics, was selected as a 150th Anniversary Distinguished Engineering Fellow of the University of Alabama's College of Engineering. Fellows are chosen from University of Alabama alumni who have brought honor to their alma mater through their accomplishments and support.
- Dr. John M. Kennedy, assistant professor of mechanical engineering and engineering mechanics, received the 1988 Byars Prize for Excellence in Teaching. This award recognizes outstanding undergraduate teaching in engineering mechanics in the College of Engineering.
- Dr. Jerry R. Lambert, professor of agricultural engineering, and a three-member team from Mississippi have received the 1988 National Mobay Cotton Research Award for the contributions of their computer information system to the cotton industry.
- Dr. William B. Ledbetter, professor of civil engineering, received the 12th Annual McQueen Quattlebaum Faculty Achievement Award on Honors and Awards Day, April 9, 1988. This award was established by Alexander M. Quattlebaum and his wife, Lucille Godfrey Quattlebaum, in honor of his father, McQueen Quattlebaum, a 1902 Clemson civil engineering graduate. The McQueen Quattlebaum Award is given to encourage faculty members to contribute to the advancement of engineering.

- Professor Jack McCormac, alumni professor of civil engineering, received two distinguished awards — the Distinguished Alumnus Award from The Citadel in April 1988 and the AT&T Foundation Award in Atlanta April 13, 1988.
- Dr. C. E. G. Przirembel, professor and head of mechanical engineering, received the 1987 American Society of Mechanical Engineers (ASME) Dedicated Service Award, which honors unusual dedicated voluntary service to the society, marked by outstanding performance, demonstrated effective leadership, prolonged and committed service, devotion, enthusiasm and faithfulness.
- Dr. Benjamin L. Sill, professor of civil engineering and engineering mechanics, received the Alumni Research Award at the May 5, 1988, general faculty meeting. This award was presented for distinguished achievements in research.
- Dr. E. B. Makram, associate professor of electrical and computer engineering, won an award for the best paper at the Institute of Electrical and Electronics Engineers (IEEE) Winter Meeting in New York City. Dr. Makram's paper was entitled "A New Laboratory Experiment for Transformer Modeling in the Presence of Harmonic Distortion Using a Computer-Controlled Harmonic Generator."
- Dr. Ben Dysart, professor of environmental systems engineering, was named an Eminent Engineer by Tau Beta Pi Honor Society in the spring of 1988.
- Dr. Beville A. Watford, assistant professor of industrial engineering, obtained a grant for a graduate intern/fellowship sponsored by the General Electric Company Gas Turbine Division in Greenville, S.C. This is the first such fellowship established in the Department of Industrial Engineering.
- Dr. Eugene H. Bishop, professor of mechanical engineering, was selected by the Clemson University student body for the 1988 Alumni Master Teacher Award. This award recognizes distinguished achievements in undergraduate classroom teaching. Also, the Clemson University Chapter of Pi Tau Sigma (National Mechanical Engineering Honor Society) established the Eugene H. Bishop Award. This award honors Dr. Bishop for his outstanding achievements as an educator.
- Dr. Cynthia C. Jara-Almonte, assistant professor of mechanical engineering, was recognized for her outstanding classroom teaching by the Clemson Pi Tau Sigma Chapter. Pi Tau Sigma selected Dr. Jara-Almonte as the first recipient of the Eugene H. Bishop Award.
- Dr. Alvon C. Elrod, associate professor of mechanical engineering, had his design for a new type of camshaft selected by *Design News* as one of the top ten design ideas in 1987. He was the only representative of a university selected for this honor. This new design permits continuous real-time variation of valve timing in two-cycle and four-cycle diesel engines, and in four-cycle spark-ignition engines.

Several members of the faculty were elected to leadership positions in professional societies. Others were asked to serve as editors or on editorial boards of professional journals during the past year. Dr. James M. Haile, professor of chemical engineering, was named North American regional editor of *Molecular Simulation*, an international journal devoted to molecular-scale computer simulation. Dean J. Charles Jennett, professor of environmental systems engineering and dean of the college, has been appointed to the Advisory Committee of the South Carolina Chemical Emergency

Response Commission. This committee, part of a comprehensive emergency management plan, provides guidance and advice to the commission, helping to make South Carolina a safer environment for the citizens, visitors and industries. Dean Jennett also serves on the Governor's Nuclear Advisory Council and was president of the Piedmont Chapter of the South Carolina Society of Professional Engineers in 1987-88. Dr. Chalmers M. Butler, professor of electrical and computer engineering, was elected a member of the Administrative Committee of the Institute of Electrical and Electronics Engineers (IEEE) Antenna and Propagation Society.

Dr. R. J. Schalkoff, associate professor of electrical and computer engineering, has been named an associate editor of the international journal *Image and Vision Computing*. Dr. Ben Dysart, professor of environmental systems engineering, was one of the three Honorary Members elected in 1987 by the Board of Directors of the 35,000-member Water Pollution Control Federation, the largest professional society in the environmental engineering field. Also, the United States Department of the Interior has named Dr. Dysart to a three-year term on its newly formed 13-member Glacier National Park Science Council. Dr. Alan W. Elzerman, associate professor of environmental systems engineering, was elected treasurer of the Division of Environmental Chemistry of the American Chemical Society. Dr. William J. Kennedy Jr., professor of industrial engineering, was appointed to the editorial board of *The Engineering Economist*. Dr. Robert P. Davis, head and professor of industrial engineering, was appointed to the editorial board of *Manufacturing Review*.

Students

College of Engineering students have received University, regional and national honors and recognition. A few examples of these outstanding students are listed below.

- Stephanie Wise (B.S. Ceramic Engineering, 1988, Magna cum laude-departmental honors) received a National Science Foundation Creativity Award in Engineering to support her graduate work at Clemson during the next three years. She will work on a project in superconductivity in the Department of Ceramic Engineering under the direction of Dr. C. C. Fain.
- The Clemson Student Chapter of the American Institute of Chemical Engineers (AIChE) won the Outstanding Chapter Award at the AIChE Regional Convention held at the University of Kentucky.
- David Lee Walters, a December 1987 graduate of computer engineering, received a Fulbright Scholarship to study at the Technical University of Munich, Germany. Walters, a native of Jacksonville, Fla., intends to study the navigation of mobile robots. Of 650 applicants nationally, only one in five is selected by the Council for International Exchange of Scholars.
- Frank Dunnivant, Charles Shorten and Geoffrey Germann, graduate students in environmental systems engineering, each received \$500 Graduate Research Paper Awards for papers presented at special symposia of national meetings for the Division of Environmental Chemistry of the American Chemical Society.

- Karen V. Guglielmone and Sandra G. Braswell, graduate students in environmental systems engineering, were among 100 invited participants at the Forum on Managing Hazardous Materials in New York City in May. The three-day forum of leaders and experts from industry, government and academia was convened by the Rene Dubos Center for Human Environments.
- The Clemson University Chapter of the Institute of Industrial Engineers (IIE) received its third consecutive Award of Excellence for chapter development activities. Dr. Beville A. Watford is faculty adviser.
- Uday Venkatadri received the Institute of Industrial Engineers Graduate Research Award for his master's thesis research. This is the second consecutive year in which a Clemson industrial engineering graduate student has won this award.
- Brian L. Marley, a senior in industrial engineering, was selected by the Institute of Industrial Engineers to receive a Dwight D. Gardner Scholarship.
- James D. Amstutz, Mary Y. Bamert, Kevin N. Earnest, Frank Heinsohn and Andrea T. Thompson were selected for the 1987-88 "Who's Who Among American Universities and Colleges."
- Mary Y. Bamert received the Faculty Scholarship Award, which honors the Clemson University student(s) for highest scholastic achievements. She graduated with a perfect grade point ratio of 4.00.
- A group of mechanical engineering students won the 1988 American Society of Mechanical Engineers (ASME) Regional Student Conference Design Contest.

Instruction

The College of Engineering is the largest academic unit on campus in terms of enrollment and degrees granted. Fall 1987 enrollment was 3,460; 2,925 of these students were undergraduates and 535 were graduate students. For 1987-88, 437 baccalaureate degrees were awarded, in addition to 111 master's degrees and 12 doctorates.

The Department of Chemical Engineering continues to experience growth in its graduate program. During 1987-88, graduate student enrollment reached a high of 31 full-time students. Roughly one third of these are Ph.D. students and three quarters are U.S. citizens. The chemical engineering undergraduate program is also very successful. The demand for B.S. graduates in chemical engineering from Clemson was higher by a factor of two compared to recent years, based on the number of job offers. This fact was further substantiated by an article in the *Anderson Independent-Mail* (May 2, 1988), which showed starting salaries for Clemson chemical engineering graduates averaging over \$1,000 more per year than comparable data for national averages.

Within the Department of Electrical and Computer Engineering, the Summer Master of Engineering Program, established in 1980 and totally funded by AT&T Technologies, continues to receive strong support. For the first summer session of 1988, 75 students were enrolled. This year's graduating class has four students who will receive a Master of Engineering degree. This will bring the number graduated from this program to ten.

The Electrical and Computer Engineering Department's Industrial Graduate Fellowship Program has also proven a success. This program was established to encourage outstanding U.S. citizens to attend graduate school. To date, 35 M.S. candidates and six Ph.D. students have participated. Each student receives a fellowship ranging from \$3,000 to \$5,000 and a graduate assistantship, providing total support, ranging from \$9,000 to \$12,800 for the academic year. In addition, each fellow is provided a summer job opportunity.

The Industrial Engineering Department's PARATEC (PARAprofessional TECHnical) Student Field Project Program continues to provide challenging and practical engineering project experiences for students. These projects are conducted in local industries. In addition to enhancing a student's education through professional practice and experience, this program provides a valuable engineering resource to participating industries. Over 150 projects are completed in a typical year.

The Department of Mechanical Engineering has initiated a Senior Honors Program through Calhoun College. This program provides exceptional and mature students of mechanical engineering an opportunity to conduct an in-depth research project under the guidance of a faculty adviser. This program offers excellent training in intensive research for students wishing to pursue a graduate degree. It also provides a valuable experience for students desiring to work in industry upon completion of the baccalaureate degree program.

The Freshman Engineering Program continues to grow and to help guide first year engineering students in their choice of an engineering major. The Freshman Engineering Program has the highest enrollment of any department on the campus, with just three staff members advising the students. Yet, reports from the students indicate they are pleased with the program and feel the goals of the program are being achieved. The program was established to improve student advising during the critical freshman year, and it is designed so that should a freshman choose, he/she can transfer to any program at Clemson University without losing credits. Enrollment in the Freshman Engineering Program (including freshmen and transfer students) in fall 1985 was 748; fall 1986 was 1,152; fall 1987, was approximately 1,000. (Note: The program began in fall 1985; therefore, all 748 students that year were new freshmen or transfers. In fall 1986, 875 of the students were new. In fall 1987, we had 871 new and 74 transfer students in the program.)

In January 1988 a new computer laboratory with 50 personal computers and 25 printers became operational in Lowry Hall. This computer facility supports the Freshman Engineering Program, and its development assures that our students will have vital computer training in the freshman year.

We are pleased to announce the launching of an aggressive five-year, multi-million dollar computer plan to complement the entire undergraduate instruction program. The objective of the plan is for each engineering undergraduate to have computer training and experience throughout his/her program of study at Clemson. The College of Engineering hopes to add 200 high-end engineering workstations with the most current software for computer-aided design and computer-aided engineering activities. Additionally, 150 new microcomputers must be provided to complement the present laboratory equipment. In the late spring of 1988, the college expended \$300,000 for 22

engineering workstations and \$5,000 in renovations for its first CAD/CAE laboratory coming on-line during the summer of 1988.

The Clemson Career Workshop for high school students marked its 11th year of operation in 1987-88. Under the direction of Dr. Robert W. Snelsire, associate professor of electrical and computer engineering, the program serves approximately 350 students per year. In 1988 over 900 students applied for 210 available spaces in the program. Engineering plays a major role in the workshop. Both this program and a minority scholarship program are sponsored by industry and foundations.

The demand for women and minority engineers continues to increase. A promising indication of our ability to satisfy this increased demand is the strong enrollment of minority and female students in the College of Engineering. Yet, despite a good enrollment of minority students in engineering, a growing concern over minority student retention led the College of Engineering to create the Program for Engineering Enrichment and Retention (PEER). Established in the fall of 1987, PEER is an innovative peer counseling program for black freshmen in the College of Engineering. Freshmen, in groups of six or eight, are assigned to an upper division minority engineering student who serves as the students' mentor. The mentor makes regular contact with each freshman, offering advice and support. Preliminary retention studies of the 1987-88 freshman year suggest that the program has been successful. Although the program is new, the participating students feel that PEER has made a big difference in their attitudes toward college.

The college received scholarship funding from the National Council for Minorities in Engineering (NACME) in 1987-88 for the third consecutive year. Institutions are selected on the basis of minority enrollment in engineering. Funding is provided for the student throughout his/her program of study when acceptable academic progress is shown. Clemson has participated in the Incentive Grants Program of NACME since 1985 owing to the increasing minority population in the College of Engineering.

Research

Clemson University continues to be an engineering research leader among institutions of higher education in South Carolina and the nation. Engineering research at Clemson has three essential aims: to seek new knowledge, to seek solutions to both the short- and long-term technological problems of the state and nation, and to support advanced-level educational programs by providing significant research experiences for students.

Clemson's College of Engineering traditionally receives a greater percentage of research funds from industry than do engineering departments at most other universities. The dollar amount of contracts and grants has increased each year for the past four years, with a record-breaking \$10.3 million of funded grants and contracts-in-force in 1987-88. Contracts and grants awarded were \$5.2 million in fiscal year 1987-88. During the past year, 109 faculty were engaged in research supported by 304 graduate students, 112 undergraduate students and 19 staff members (temporary and permanent) and visiting scholars.

Major Equipment Gifts to the College

The College of Engineering received many major equipment gifts from corporations and industry in 1987-88. This type of industrial support is vital to enhancing educational opportunities for students and research facilities for faculty. Some of these equipment gifts are listed below.

- NCR Corporation donated approximately \$25,000 of computer equipment for the image processing laboratory in the Agricultural Engineering Department.
- Powell Brothers Manufacturing of Bennettsville, S.C., donated a \$25,000 high-boy sprayer to the Agricultural Engineering Department for use with mechanization work in vegetable production.
- Leeds and Northrup donated a Microtrac Particle Size Analyzer valued at \$50,000 to the Ceramic Engineering Department to aid research in ceramic processing.
- Occidental Chemical Company donated three gas chromatographs, several laboratory balances and vacuum pumps, and other research equipment valued at \$69,500 to the Department of Chemical Engineering.
- The NCR Corporation/Mentor Graphics, Inc., Computer-Aided Design Laboratory, valued in excess of \$400,000, was installed and used by the first group of students in spring 1988. The hardware was provided by NCR and the software by Mentor Graphics.
- Square D Corporation donated electrical circuit breakers with ground-fault interrupt valued at \$895 to the Electrical and Computer Engineering Department. The breakers were installed by our technicians to improve electrical safety in our teaching labs.
- The 3M Corporation donated equipment valued in excess of \$19,000 to the Electrical and Computer Engineering Department for the Effective Technical Communications Program.
- The Department of Industrial Engineering was given a complete manufacturing cell from Microbot, Inc., valued at \$35,000.
- Sun Microsystems of Mountain View, Calif., has given the College of Engineering an equipment grant worth more than \$450,000. The grant consists of a significant discount on the purchase of 22 SUN 4/110 color workstations and a SUN 4/280 fileserver representing the latest in state-of-the art CAD/CAE workstations.

In addition to equipment gifts, the College of Engineering receives cash donations from industry and corporations to assist in the development of research programs and teaching facilities. We also have generous support from alumni, friends and other private sources.

Research Centers

Clemson's College of Engineering is aggressively expanding its role as a major research institution through its research centers of excellence. These centers are: the Center for Semiconductor Device Reliability Research, the Center for Advanced Manufacturing, the Center for Computer Communications Systems and the Center for Engineering Ceramic Materials. Each of these centers focuses on a particular area of research supported by faculty with recognized expertise in that area.

The Center for Semiconductor Device Reliability Research completed its fourth year of operation. It is the only comprehensive academic program in the nation investigating the degradation of semiconductor components after manufacture, a costly problem which increasingly concerns industrialized nations.

During 1987-88 six faculty members and 13 graduate students participated in the Semiconductor Research Center, primarily in research involving very large scale integrated (VLSI) circuits. Billings were \$479,000, most of which came from the Semiconductor Research Corporation (SRC), an industry consortium. Last year, the center attracted widespread interest by demonstrating RELIANT, a computer program designed to simulate the life-span testing of components.

The new Electrical and Computer Engineering Microelectronics Cleanroom, located in the Riggs Hall basement, is now fully operational, and mask patterns for a number of applications have been generated. This \$2 million facility (funded principally by state funds but with major donations also given by IBM and ITT), together with the VLSI design facility, will be used during the coming year to produce various custom-designed reliability test structures for center studies. The Center for Semiconductor Device Reliability Research is under the direction of Dr. Jay W. Lathrop, and the Microelectronics Cleanroom is supervised by Dr. Kelvin Poole; both are professors in the Department of Electrical and Computer Engineering.

Dr. Frank W. Paul, McQueen Quattlebaum Professor of mechanical engineering, continues to direct the Center for Advanced Manufacturing (CAM). The center was known as the Engineering Center for Automated Manufacturing Technology until July 1987 when the South Carolina Commission on Higher Education authorized the name change.

During 1987-88 the center had two industrial members — the Torrington Company and Hoechst-Celanese Company — and two industrial affiliates — Reliance Electric Mechanical Group and Kellogg-Rust Corporation. Funding from the members and affiliates was approximately \$109,000; \$5,000 was added to the CAM Center endowment fund principal, bringing the total principal to \$22,500. Investment income has increased this amount to approximately \$26,000. Contract research funding through the CAM Center was approximately \$354,000 for the 1987-88 fiscal year. This is an increase of approximately 145 percent over the previous fiscal year.

The center is developing an industrial consortium emphasis in metal matrix materials manufacturing. A white paper describing an industrial consortium has been developed for support in this area. Contacts have been made with two potential industrial sponsors to participate in the program, and a laboratory with manufacturing capabilities in this area is being developed through the support of the Center for Advanced Manufacturing and the South Carolina Energy Research and Development Center.

Efforts are in progress to establish a Robotics Working Group made up of faculty members from electrical and computer engineering, mechanical engineering and mathematics. This group is developing a working relationship with the Oak Ridge National Laboratory to explore a joint research program in advanced intelligent robotic systems for maintenance and remanufacturing of nuclear power facilities.

Bioengineering Alliance of South Carolina

The Bioengineering Alliance of South Carolina was approved in July 1985 by the South Carolina Commission on Higher Education. Under the leadership of Dr. Andreas F. von Recum, chairman, and Dr. R. Larry Dooley, research director, the alliance has developed into a unique university-industry-state partnership. The alliance's research thrusts are focused in these areas: artificial intelligence applied to computer-aided design of custom joint replacements, development of advanced surface science techniques for biomaterials and advanced diagnostic techniques for cardiovascular disease. The alliance has received support from nine industrial sponsors. The first year's state seed funding of \$170,000 has been leveraged to over \$600,000 in support, yielding a three-to-one return on the state's investment.

The advanced manufacturing techniques under development within the alliance have potential, not only for the health care industry, but for many state industries. The Bioengineering Alliance is actively pursuing licensing agreements for its advanced manufacturing technology.

Specific Research Projects

The departments within the College of Engineering are actively engaged in research projects. A partial list of current projects indicates the diversity of research at Clemson.

In the Department of Bioengineering, Dr. Dooley, his collaborators within the Bioengineering Alliance of South Carolina and his graduate students, have demonstrated the feasibility of using artificial intelligence to fabricate custom-design artificial hips. Currently, orthopedic implant manufacturers require six weeks of intensive manual labor for custom-design prostheses. The new process can produce a product within 12 hours, utilizing available CAD/CAM technology, artificial intelligence and a programmer. The commercial input on orthopedic implant manufacturing has been realized by a number of corporations, and negotiations for large-scale collaborations are in progress.

Also in bioengineering, Dr. Andreas von Recum and graduate student Craig Campbell were able to document that biocompatibility of an implant is predominately determined by surface roughness measured in micrometers. This finding contradicts current understanding that bulk chemistry determines the implant's acceptability. These findings have a significant impact on future biomaterials research and are of great commercial value. A major hospital products manufacturer is negotiating the exclusive rights to this discovery.

Faculty members in agricultural engineering have conducted research to incorporate image processing in an orchard sprayer, thereby reducing the need for expensive pesticides and protecting water quality. Aquaculture research is being conducted at Clemson to increase the efficiency of catfish production. This includes work on harvesting, feeding and aeration for a growing agricultural industry in South Carolina.

The discovery of novel ways to produce ceramic fibers and filaments from superconducting ceramic materials is receiving top priority in the Department of Ceramic Engineering. NASA supported one phase of this work during 1988 and will continue its support during 1989. Also, several fiber-producing companies are supporting work carried out jointly between the departments of chemical and ceramic engineering. The main goal of the work is to explore methods to produce very high-strength, damage-tolerant carbon fibers.

Two faculty members in the Department of Chemical Engineering, Dr. M.C. Thies and Dr. A.A. Ogale, received funding from the National Science Foundation for Research Initiation Grants. Professor Ogale's project will be aimed at developing a "Superconductive Composite Wire," and Professor Thies' work will be directed toward the elucidation of "Aqueous Biocompound Mixtures at Elevated Temperatures and Pressures."

The South Carolina Department of Highways and Public Transportation awarded two research projects to the Department of Civil Engineering for development of computer programs for the asphalt mix design units. The other project is a study of the reusing of moisture-damaged asphalt mixtures. The object of another project in civil engineering is to analyze groundwater contaminant transport with three-dimensional scaled models. Finally, the Department of Civil Engineering has received a grant from the National Science Foundation to hold a workshop to determine research needs for masonry.

Funded research projects in the Engineering Graphics Program include: a National Science Foundation grant to study the mathematical modeling of solid surfaces, and a grant from National Advanced Systems (NAS) to modify an existing software modeling program (MOVIE.BYU) to execute on the NAS AS XL-V60 mainframe computer at Clemson.

The Division of Engineering Services, which is a research support group in the College of Engineering, acquired a new three-axis computer-controlled vertical milling machine. This equipment will enable research machinists to do more precision work in the area of materials research.

Duke Power supports two research projects in the Environmental Systems Engineering Department. One project deals with evaluating and improving the performance of environmental protection systems, as well as assessing the residual impact of off-site streams, at the billion-dollar Bad Creek Hydroelectric Station. The other project focuses on determining the quality of several important cold-water aquatic ecosystems in the vicinity of Duke Power's proposed 3.8 billion-dollar pumped storage hydroelectric station on Coley Creek above Lake Jocassee. Both projects are contributing substantially to the improvement of methods for siting, designing, building and operating major energy production facilities in an environmentally acceptable manner.

ESE research on the distribution, fate and controlling processes of PCBs continues to progress. A survey of Lake Hartwell has been completed, and the total load of PCBs in different areas of the lake has been estimated. Models to predict future distributions and effects and to assess potential remedial actions are being developed.

A study sponsored by the South Carolina Department of Health and Environmental Control was performed by environmental systems engineers to make a preliminary evaluation of indoor radon in the state. Over 600 houses were sampled throughout the state, and the data were used to identify regions where radon concentrations are likely to exceed the Environmental Protection Agency's action level of 4 pCi/L.

The disposal of waste oils containing radioactive contamination is a problem throughout the nuclear industry. Environmental systems engineers are developing techniques for removing radioactivity from waste oils. The research, sponsored by Carolina Power and Light Company, focuses on the effectiveness of a variety of physical and chemical decontamination processes.

The South Carolina Water Resources Research Institute is sponsoring a project to investigate the fate of volatile liquids spilled on soil. This project looks at the relative roles played by the evaporation of the liquid, which releases it into the atmosphere, and the downward transport with the groundwater. The results of this research will assist in the cleanup of spills of hazardous chemicals.

In the Department of Industrial Engineering, Dr. R. P. Davis is developing a design framework for the decomposition, analysis and configuration of systems, using a component specification and selection methodology. This framework is applied to the design of machining centers, material handling equipment and control system software for automated manufacturing. Dr. Carl R. Lindenmeyer is engaged in ergonomic study leading to the design of a generic work simulator for injured patient rehabilitation and evaluation.

The utilization of artificial intelligence concepts to address manufacturing research areas is being investigated by Dr. Beville A. Watford, a professor of industrial engineering. The National Science Foundation provided support for proposal preparation addressing the development of an Artificial Intelligence (AI)-based computer-aided process planning system. The proposed research involves specification and development of a manufacturing capability knowledge base, which may be accessed to determine the feasibility of processes required by a particular product design. Simulation modeling and analysis are being addressed with respect to the development of an AI-based output analysis processor, and methods for validating and verifying simulation models are being studied. This work is a continuation of previous research involving simulation program generator development.

The Department of Mechanical Engineering is pursuing a project entitled "Deformation Processing of High Temperature Metal Matrix Composites." The project experimentally examines the deformation behavior of short fiber and particulate-reinforced metal matrix composites during thermomechanical processing. A generalized plasticity model is being developed that will take into consideration material, thermal and boundary effects, and will be used to predict composite metal flow during elevated temperature processing. High temperature metal matrix composites have major applications in the National Aerospace Plane Program.

Research by mechanical engineers is also being done for DuPont and the Savannah River Laboratory on performance characteristics of a hydraulic sampler system for a nuclear processing plant. A prototype air-lift pump and degasser system have been designed, fabricated and tested for a range of operating conditions and working fluids. Analytical and experimental optimization studies are being conducted. The new system will significantly improve the safe processing of liquid nuclear materials.

An experimental investigation of the fluid mechanics and heat transfer in the boundary layer undergoing transition flow over curved surfaces is under way in the Mechanical Engineering Department. A special test facility has been designed and built. The results of this work will improve the rational design methods of flow around gas turbine blades and will permit more precise prediction of the thermal efficiency of gas turbines.

Mechanical engineers are also conducting experimental and analytical studies of flexible-linked robotic manipulators. Classical and modern design methods are being

used to reduce the adverse effects of vibrations and flexure in order to improve the accuracy of robot arm motion. The results will allow more rapid and precise handling of parts in advanced manufacturing systems.

The Department of Mechanical Engineering is also engaged in analytical and experimental studies of composite material torque tube end fittings for a major aerospace contractor. These tubes are used in the servo-mechanical control of aerodynamic surfaces. Weight and reliability are major design factors. The results can be extended to the design and fabrication of many consumer products.

Finally, a proprietary feasibility study to automate the loading of computer-selected yarn into Axminster carpet looms is being conducted. Hardware and software are being developed and tested on a 27-inch loom.

Books Published

Engineering faculty are active in the publication of informative texts on various research efforts and teaching methods. In addition to the many journal articles, conference proceedings and technical papers written by faculty members this past year, several professors had books published.

Jack C. McCormac and Rudolf E. Elling, professors in the Department of Civil Engineering, co-authored *Structural Analysis: A Classical and Matrix Edition*, published by Harper & Row Publishers, Inc., New York, New York. A. Wayne Bennett, professor and head of the Department of Electrical and Computer Engineering, co-edited *Systems Modeling and Computer Simulation*, published by Marcel Dekker, Inc., of New York. John J. Komo, associate professor of electrical and computer engineering, authored *Random Signal Analysis in Engineering Systems*, published by Academic Press. Daniel F. Ryan, professor of Engineering Graphics, authored *Computer-Aided Design for AutoCAD Users* in 1988.

The *Effective Technical Communications Manual* is being published by Ginn Press. The authors of the manual, Professors Dan McAuliff, Claire Caskey, Vera Anand, and Doctors E.G. Baxa, William West, Campbell Martin and Doyle Holstead, agreed to return the royalties to the Effective Technical Communications (ETC) Program. The sales of the manual for the first two months resulted in \$650 being contributed to the Clemson University Foundation. The National Society of Professional Engineers (NSPE) has adopted the ETC Program and plans to distribute ETC videotapes to every student chapter in the United States.

Public Service

In its role as the primary public service activity of the College of Engineering, Continuing Engineering Education (CEE) provides effective training for practicing engineers to maintain their competitive position in an environment of constant technological change. CEE offers training through a wide variety of local and national seminars, short courses and workshops. A summary of the 1987-88 program is shown below.

Type of Offering	Number	Program-Days of Effort	Total Attendance
Seminars, workshops, short courses	62	96	1,141
Major conferences	7	15	802
EIT/PE reviews	105	105	2,213
In-house seminars (for industry)	11	18	245
TOTALS	185	234	4,401

Major conferences were held in the areas of biotechnology, food science, synthetic fiber production, advanced engineering fibers and environmental engineering. New programs developed included a two-day workshop in fine particle technology, which drew participants from 28 states, and a one-day seminar in Fiber Reinforced Composites.

J. G. Goree, professor of mechanical engineering and engineering mechanics, was invited by the NASA-Langley Research Center to present a two-week short course, Complex Variable Methods in Plane Elasticity. The course was attended by leading researchers in elasticity and fracture mechanics.

In an effort to help engineers make the transition to engineering management, CEE has developed an Engineering and Technical Management Series, consisting of four to five courses in management. In addition, a two-day course, Quality Control in Project Management, was offered at two locations. A successful one-day program emphasizing professional development for women engineers was presented.

Programs were offered in electrical power systems, electric motors, statistical process control, manufacturing process simulation, technical writing, heating and air conditioning, quality assurance in design, brick manufacturing, hazardous waste and soil mechanics. CEE continued to offer review courses to prepare engineers to take the Engineer-in-Training and Professional Engineer examinations. This series was also offered to Duke Power and Georgia Electrical Membership. The number of in-house programs increased this year to 11 for a total of 19 program days. A major goal of CEE is to work with a larger cross section of industry to develop a broader offering of in-house courses.

COLLEGE OF FOREST AND RECREATION RESOURCES

The report of 1987-88 activities for the College of Forest and Recreation Resources' resident instruction, research and Extension programs is included under the Division of Agriculture and Natural Resources on page 114.

COLLEGE OF LIBERAL ARTS

It has been said that no university will ever become a great institution of higher learning without a strong program in the humanities, arts and social sciences. The College of Liberal Arts recognizes the validity of this observation. In addition, it subscribes to the notion that a self-governing society requires of its citizens a basic and general education that will enable them, regardless of their occupations or professions, to lead full and thus useful lives, and to contribute to the general welfare of society. Throughout the country, the liberal arts are flourishing once again, and such activity is evident as well at Clemson University.

For example, 11 percent of the undergraduates major in the liberal arts, up from 7 percent just five years ago; the faculty of the college teach approximately one quarter of the credit hours taken by students; and the college offers a number of courses that fulfill the "general education requirements" of the University.

The College of Liberal Arts is composed of the departments of English, History, Languages, Performing Arts, Political Science, Psychology and Sociology. During the year under review, plans were formalized for the formation of the new Department of Philosophy and Religion, which came into being July 1, 1988. With the exception of Performing Arts, all departments offer majors leading to the Bachelor of Arts degree, and English and History offer programs leading to the Master of Arts degree.

Close to 90 percent of the tenured and tenure-track Liberal Arts faculty hold the doctoral or other terminal degree. The graduates of the college enter some of the outstanding graduate and professional schools in the country; and many of them, of course, pursue careers in business (including the service industries), industry and government upon taking their undergraduate degrees from the University.

Faculty Highlights

Three highly respected journals emanate from the College of Liberal Arts. The South Carolina Review is edited and published by faculty members in the Department of English. This distinguished magazine provides a forum for literary scholarship and criticism, as well as for outstanding poetry and short stories. Normally published twice a year, The South Carolina Review published a third issue this year entitled "Robert Frost Annual," which was distributed to all members of the Robert Frost Society. The Journal of Political Science, with an international editorial board under the leadership of a faculty member in the Department of Political Science, boasts a list of authors from leading universities and colleges from this country and from overseas. This journal emphasizes the scholarly contributions of younger researchers and addresses contemporary themes, evidenced by an issue this year devoted to "Religion in American Politics." The Department of Languages edits and publishes The Comparatist, which is devoted to the literary and language interests of scholars in the Southeast and which is the official publication of the Southern Comparative Literature Association.

Liberal Arts faculty also continue to be very active in scholarly and creative endeavors. They deliver papers at numerous regional, national and international meetings and

conferences; they contribute articles, as well as poetry and fiction, to a variety of established and influential journals; they edit book-length collections and prepare textbooks; and they write books in their areas of expertise that are issued by respected publishers and that receive favorable notices in the press.

In addition and as further acknowledgment of the increasing recognition of the Liberal Arts faculty in the disciplines it represents, faculty now often serve as officers in and as board members of a number of professional organizations and societies; they also serve on editorial boards of journals in their areas and as manuscript referees for presses.

Other departmental activities include, but are not limited to, the following: a syndicated book review column originating in the Department of History and published in newspapers across the country; a book review service originating in the Department of English that specializes in children's books; research conducted by the Department of Psychology on a variety of topics such as aging, laterality of brain function, stress management, computer-assisted instruction, artificial intelligence, the development of pattern vision in children, eating disorders and substance abuse; and research conducted by faculty in the Department of Sociology encompassing several areas, including the prison system, police-community relations, parental grief, parental abuse, children's responses to crises, alcohol consumption and abortion.

Regular features of the College of Liberal Arts include gatherings of scholars and creative writers. For example, the college often conducts programs in cooperation with the Strom Thurmond Institute of Government and Public Affairs. Other annual affairs include events in observance of Black History Month and Women's History Week. This year the college continued the Women's Studies Colloquia, sponsoring six lectures on timely topics.

One highlight of the year that does not fit conveniently into any of the categories of this report was the identification of the Pulitzer Prize winning journalist, Harry S. Ashmore, a former English major, as the University's most distinguished alumnus.

Public Service

The public service roles played by the College of Liberal Arts throughout the state and region continue to grow. Political Science faculty are frequently called upon by units of local and state government, as well as business and industry, for advice in such areas as poll-taking, taxation and governmental organization. In addition, political scientists serve frequently as panelists for civic organizations and consultants to both the print and electronic media on national and international affairs.

Sociologists contribute their expertise in such areas as the design and analysis of social surveys, the impact of industrial development on society, and program development and evaluation in the fields of prison reform, spouse abuse, mental health and alcohol and drug problems. Faculty in Sociology also offer workshops in staff growth and development for both private and public service agencies. Psychologists provide clinical service to Clemson's Redfern Health Center, management training for area industries and hospitals, consultation on jury selection, eyewitness validation and

expert witnesses on criminal sanity, survey studies for local and state agencies and a weekly newspaper column on labor relations. English faculty work with both business and industry by conducting seminars and workshops in business and technical writing.

In addition to offering a traditional language program, the Department of Languages emphasizes a practical, business orientation. Given the large foreign investment in South Carolina industry and the need to develop overseas trade markets, the new Language and International Trade major represents an especially apt response. The Department of Languages also sponsors an annual Language Declamation Contest, which draws hundreds of participants from South Carolina and nearby states. Languages also conducted 1988 summer foreign study programs in France and Mexico. Recognition of Clemson's language students came this spring when the national Fulbright Award Committee selected two students for scholarships to study for a year in Germany.

Among the recipients of the college's public service endeavors are the state's school-teachers. Improved civic education in the state's public schools is the goal of the Thurmond Seminar, which is conducted by the Department of Political Science with funds from the Strom Thurmond Institute for Government and Public Affairs. Twenty social science teachers from South Carolina's secondary schools participated in this summer's seminar, with classes held both in Clemson and Washington. As part of the Educational Improvement Act, summer institutes were conducted on campus for Advanced Placement (AP) teachers in American government and American history.

Twenty-four Piedmont-area teachers of writing attended the sixth Summer Institute of the Clemson Writing Project, sponsored by the Department of English and the College of Education. The Bread Loaf Rural Writing Network joins Middlebury College's Bread Loaf School of English and Clemson's Department of English in a collaboration that involves the two institutions cooperating to administer grants to teachers and students in several public schools in the state. Piloted by the Bread Loaf Rural Writing Network in South Carolina, Project REACH (Rural Education Alliance for Collaborative Humanities), which is funded by a Rockefeller Foundation grant channeled through the South Carolina Committee for the Humanities, operates out of a base in the Department of English.

Members of the college faculty also serve as program leaders for the South Carolina Committee for the Humanities. Again this spring they helped organize, conduct and contribute to the Piedmont Humanities Forum. With leadership provided by a faculty member in the Department of History, the Palmetto Program in the Humanities brings together faculty from the departments of English, History (including the Philosophy and Religion section) and Political Science to present programs for the elderly residents of Keowee Key in Oconee County. In addition, faculty in the Department of Performing Arts regularly perform and serve as judges in the state and region.

The College of Liberal Arts serves the entire student body of Clemson University in a variety of ways other than through direct classroom instruction. For example, the Model United Nations Program, which is sponsored by the Department of Political Science, annually competes in and has won awards at national conferences in cities such as Boston, New York, Philadelphia and Washington, D.C. Political Science also sponsors the State Student Legislature and the government internship program, the

former involving an annual competition in Columbia and the latter involving students participating in local, state and national government. The Department of English operates the Writing Laboratory, which is open to all students with writing deficiencies.

The college also contributes to University life by sponsoring a number of student organizations and extracurricular activities. For example, the Department of Performing Arts oversees the Clemson Players, the student drama group that presents four plays during the academic year and two during summer school. In recent years, these productions have received regional and national recognition. Many musical activities are also under the direction of Performing Arts: the University Concert Series, Robert and Lillian Utsey Chamber Music Series, and student organizations including Tiger Band, Symphonic Band, University Chorus, C.U. After Six Singers and Jazz Ensemble. The department also sponsors an active speech forensics program. The Gospel Choir is sponsored by the Department of History, while the Department of English provides faculty advisers for the following student publications: The Calhoun Literary Review, The Chronicle and The Tiger, the student newspaper which has earned a number of collegiate press awards.

The state's public school students make up yet another constituency served by the College of Liberal Arts. The Department of Psychology cooperates with the colleges of Engineering and Sciences in offering a series of summer science camps for gifted junior high and high school youth. The Department of Languages continues to offer instruction in French, German and Spanish to area elementary school students, and the Department of History continues to hold its History Day competition for precollege students in the Third Congressional District.

Program Development

Language and International Trade was introduced as a new undergraduate degree program this year, with language components in French, German and Spanish, and professional components in global marketing, international agricultural trade, international forest products marketing, international textile marketing and international tourism marketing. With 152 majors already, Language and International Trade represents one of the bridges erected by the College of Liberal Arts to span the gap between the liberal arts and the scientific and technological disciplines on campus. This major joins the College of Liberal Arts with the colleges of Agricultural Sciences, Commerce and Industry, and Forest and Recreation Resources in a most successful interdisciplinary effort.

Another successful interdisciplinary effort that brings the colleges of Engineering, Liberal Arts and Sciences together is the "Writing Across the Curriculum" program, which involves specially identified faculty from the Department of English working with faculty from Engineering and Sciences to foster the writing skills of students enrolled in courses in these two colleges. The Commission on Higher Education granted approval this year for the Department of Psychology to offer a Master of Science degree in Applied Psychology with tracks in human factors psychology and industrial/organizational psychology. The first entering class of graduate students in this degree

program will begin studies in the fall 1988 semester. On-campus approvals for new offerings included, but were not limited to, a new minor concentration in women's studies and courses in the Japanese language. In addition, courses in anthropology are once again being taught.

In sum, the College of Liberal Arts continues to make progress on all fronts and looks forward with enthusiasm to entering its twentieth year as a separate college.

COLLEGE OF NURSING

The College of Nursing offers academic programs leading to a Bachelor of Science degree and a Master of Science degree in nursing, and health courses available as electives to all non-nursing majors. Professional development programs for nurses, other health-care workers and lay persons are offered through the Continuing Education Program. The Nursing Center provides health-care services to the public and serves as a site for student and faculty practice and research in clinical nursing. The Wellness Program offers wellness services to all faculty and staff of the University.

Administration

Dr. Opal Hipps was appointed dean of the college August 1987. She had served on the faculty from 1969 to 1979. During her first year as dean, an innovative organizational model for decentralizing college operations was implemented. This model called for the establishment of three departments.

Academic degree programs in nursing and courses in health are implemented by faculty in the Department of Instruction under the direction of Dr. Robbie Hughes. Programs of professional development and delivery of professional services to the broader community are administered by the Department of Professional Development and Services under Dr. Sara Barger. Currently these include the Continuing Education Program, the School Nurse Practitioner Program, the Nursing Center and the University Wellness Program. Promotion and coordination of faculty research efforts and the oversight and administration of grants are the responsibility of the Department of Research under the direction of Dr. Mary Ann Kelly.

The current administration also includes two positions established to enhance achievement of college goals. Director of Development Teresa Farris assumed responsibility March 7, 1988, for the college's fund-raising, alumni and public relations programs. Dr. Pam Kline, appointed associate dean January 1, 1988, serves as the college's primary liaison with external affiliating agencies and coordinates internal services that support the instructional program and other college functions. These support services include the Media Resources Center, student services, recruitment and retention, and transportation and scheduling.

Teaching

A total of 96 students were graduated from graduate and undergraduate degree programs during the 1987-88 academic year. Results of a 1987 survey by the University Placement Office indicated that 97.6 percent of surveyed nursing graduates were employed full time, all felt their job was directly related to this major, and none were unemployed who desired employment.

An extensive recruitment plan for the college was implemented during the past academic year. Efforts have included distribution of a videotape, "Why Nursing," to all South Carolina high schools, revision of program brochures, establishment of new undergraduate scholarships and personal contacts with a broad market of prospective students. Anticipated enrollment of incoming freshmen based on paid acceptances for fall 1988 is nearly double the number who enrolled in fall 1987. Recruitment of minority students continues to be emphasized through implementation of the summer workshop in nursing for high ability minority students. Twenty students attended during June 1988.

The first graduate nursing course was offered by Telecampus during spring 1988, enrolling 13 students. As a result of its positive reception, two additional courses will be offered by Telecampus this fall: one graduate course and one course in health for teacher recertification.

A total of 256 students enrolled in health courses during 1987-88, indicating interest in and need for such courses among the general student population. Three courses currently offered qualify for teacher recertification within the state. Options for expanding the health course offerings are being explored.

Faculty development has taken great strides, particularly in the areas of academic preparation and research. A total of 41 percent of the faculty hold doctoral degrees while an additional 28 percent are enrolled in doctoral study. This compares favorably with the current national mean (35 percent) for faculty with doctorates in schools of nursing. Publications, research and scholarly presentations have all increased over previous years.

Research

The Department of Research began operations in January 1988. Major goals of the department are to increase research grant and contract activity within the college, to increase faculty research expertise, and to provide support services for research and scholarly activity of the faculty.

A major activity for department personnel during the spring semester has been securing resources and support services needed to increase research expertise and productivity. Computer equipment and software, space and reference material have been obtained. In addition a pilot program providing financial support for faculty and graduate students was implemented. During the spring semester six faculty and three graduate students received support from this program for research and scholarly activities.

The department has provided funding for faculty to make research presentations at scholarly meetings. Dr. Betty Baines' study of nursing assistance to families and

victims of Alzheimer's disease was funded for a second year by the National Center for Nursing Research. Dr. Lori Fisher and Dr. Ann Wetsel have submitted a proposal for federal funding for a study of the effects of increased length of time for intravenous site use in home-bound patients receiving intravenous therapy.

Future plans include securing allocation of and furnishing appropriate space in the College of Nursing building for faculty and graduate student research activity. Space is needed for storing research equipment, supplies and data collection materials as well as for preparing presentation materials and manuscripts. Plans are also being made for securing research consultation services for individuals and faculty groups.

Service

The Wellness Program was launched during fall 1987 with the employment of Lynn Lesley as the first University wellness coordinator. After surveying faculty and staff about their interests and needs, she planned and implemented a full wellness calendar of events, which included lunch-time educational programs on topics such as stress, exercise and nutrition, special screening services, a walking program and a smoking cessation program. Four hundred students, faculty and staff participated in the Wellness Challenge, a program to encourage regular aerobic exercise. In addition, wellness services were provided for several local employers, including the Clemson City Police Department.

The Nursing Center continued its health promotion/disease prevention services, including health screening and assessment, health information and support services, and immunizations to area residents. There were 3,806 client visits to the Nursing Center during the year with 114 clients using the center for the first time. Junior and senior students participated in center activities as part of their clinical laboratory experience while graduate assistants served as staff. The center's family nurse practitioner provided clinical supervision for the students in addition to being the major service provider. Revenues increased 145 percent with the rate of uncollectible fees for the year at a low of 1.5 percent.

In a new project, professional nursing services were made available to residents of the Clemson Downs Retirement Community. Under the terms of the contract with the Clemson Area Retirement Center, a faculty member from the College of Nursing completed an assessment of the health-care needs of the residents. A clinic opened on site at Clemson Downs April 1, 1988, and professional nursing services were available to clients in their homes beginning in June 1988.

The Continuing Education Program offered 55 programs to 2,576 participants during the 1987-88 academic year. Included were certification review courses and programs for nurses in specialty areas such as emergency room, occupational health and critical care. These programs generated an annual income of \$393,702, an 8 percent increase over 1986-87. In an effort to increase cost-effectiveness, the program hired a consultant to make recommendations concerning organizing and operating the program for maximum efficiency; implementation of these recommendations began late in the year.

The School Nurse Practitioner Program entered its third year. Six nurses successfully completed the program in August 1987 and received their certificates as school nurse

practitioners. Five more nurses entered the final phase of the program. Although a proposal was submitted to extend federal funding for the program for the fourth and fifth years, this extension was not obtained. However, the program received the Most Innovative Program Award for 1987 from the South Carolina Association for Higher Continuing Education.

Outstanding faculty accomplishments include the following:

- In June 1988 Dr. Sara Barger, head of the Department of Professional Development and Services, received the 1988 Honorary Nursing Practice Award of the American Nurses' Association for contributing to the improvement of the health care delivery system in the Clemson community, providing innovations in nursing practice that help and encourage peers in their practice of nursing and serving as a role model to other nurses and nursing students.
- Dean Hipps was elected to the Board of Directors of the American Association of Colleges of Nursing for a two-year term and was appointed by the South Carolina Commission on Higher Education to a panel formed to find solutions to the nursing shortage.
- Jeri Milstead, assistant professor, was selected to serve in the Washington, D.C., office of Senator Daniel K. Inouye (HI) as an adviser on health policy and nursing issues during April, May and June. Milstead also actively worked with the Appropriations Subcommittee on Labor, Health and Human Services and Education during the appropriations process.
- Milstead was elected president of the State Board of Nursing for South Carolina in December 1987. A registered nurse member of the Board, she was appointed to a four-year term by former Governor Richard E. Riley in 1986. The State Board is the official government agency responsible for protecting the public by regulating the practice of nursing in South Carolina. It approves all basic nursing programs and oversees the licensing of all registered nurses and licensed practical nurses in the state. Milstead also served as chair of the Nurse Practice Act Task Force, a statewide group representing all facets of nursing, which proposed a successful revision of the law that governs nursing.

COLLEGE OF SCIENCES

The College of Sciences had an excellent year in 1987-88 in all areas. The 1987-88 total teaching load represented 30 percent of the effort of the entire University. All programs and curricula in the University are affected by the quality of instruction provided in the College of Sciences since every major requires courses taught within this unit.

The college continues to be a leader in innovative teaching and service to the community. It is playing an increasingly large role in the nationwide attempt to improve the quality of science and mathematics teaching in the public schools. Numerous federal and state grants supported programs to strengthen the background of elementary and

secondary school teachers of science and mathematics. A joint proposal from the colleges of Sciences and Education was approved for funding by the Commission on Higher Education in May 1987. The Center of Excellence in Science and Mathematics at Clemson University anticipates the possibility of continued funding. This grant brings public school teachers to the campus and assists them in all areas of science and mathematics instruction. Plans are now in motion to add atmospheric sciences to the Department of Earth Sciences. Dr. Lawrence Dyck served as acting head of the Department of Biological Sciences and Dr. W. Edward Gettys as acting head of the Department of Physics and Astronomy this year.

In addition to the activity in undergraduate, graduate and public service instruction, the college maintains extensive research activity. The total value of all externally funded support for research at the end of this year was approximately \$13 million, which represented the largest amount of external funding from non-state sources of any college in the University. This is an increase of \$.7 million from the previous year despite a general decrease in the availability of external research funding.

Dr. Bobby G. Wixson, an aquatic and environmental biologist from the University of Missouri at Rolla, assumed the position of dean of the college in August 1987. Dr. Doris R. Helms was named acting associate dean for undergraduate education and instruction, and extensive analysis and planning was carried out for the college.

In October the college hosted a Japanese delegation here to evaluate research and teaching programs aimed toward developing a branch U.S. campus in Japan. Clemson heads the consortium of U.S. universities involved in the project. In January 1988 a second delegation from Japan visited the campus.

In March Dean Wixson chaired the international conference on Lead in Soil: Issues and Guidelines and has been elected chairman of a task force to recommend U.S. guidelines to the Environmental Protection Agency and other agencies. As part of a Clemson delegation, Dean Wixson visited Japan in March to continue negotiations on the proposed Japan campus and develop cooperative research and the exchange of faculty with Kumamoto. He also met with the president of the Chinese Academy of Science to discuss scientific exchanges with Clemson. In May the president and vice dean of sciences from Tanta University in Egypt visited the college to discuss establishing a cooperative effort between the faculty at Tanta and Clemson for joint research efforts.

Biological Sciences

The department's undergraduate major in biological sciences completed its second year with an impressive growth. Total departmental majors have increased 30 percent as of fall 1987 (63 majors in biochemistry, 148 in biological sciences and 45 in zoology). There were 27 M.S. students (seven in botany, five in biochemistry and 15 in zoology) and 37 Ph.D. students (seven in biochemistry, one in botany enrolled under the program in plant physiology and 29 in zoology). The department's doctoral program served the largest group of Ph.D. students in the College of Sciences. During the 1987-88 academic year, the department awarded 38 B.S. degrees (17 in biochemistry, 20 in zoology and its first degree in biological sciences). Graduates of the undergraduate

programs were outstanding; more than 50 percent earned *cum laude* status or higher (GPR 3.4 or better) in curricula that are considered among the University's most challenging. Among the recipients of B.S. degrees, Nancy Faye Strom was awarded the Faculty Scholarship Award (highest GPR in the University graduating class), and Frederica Lashley received a Fulbright Fellowship for continued studies abroad. At the graduate level, 13 graduate degrees were awarded by the department (five M.S. in zoology, four M.S. in botany, three Ph.D in zoology and one Ph.D. in botany through the plant physiology program).

Research and graduate education activities were supported by 37 active research grants and contracts with a total value in excess of \$2 million. Among the department's major external sponsors were: NSF, NIH, USDA, DOE, DHHS, Pioneer Hi-Bred International, Water Resources Commission, Sea Grant, American Heart Association and U.S. Air Force Office of Scientific Research. Several faculty obtained University Research Grants and Provost Awards. Among the 28 full-time faculty are: one Rhodes Scholar, one Danforth Fellow, one Guggenheim Fellow and two Fellows in the Explorers Club. One faculty member was elected to Fellow status within the prestigious American Association for the Advancement of Science during the 1987-88 academic year.

Scholarly activities by the faculty, research staff and graduate students included 82 presentations at regional, national and international meetings and conferences. As a result of the year's activity, the faculty have published, or have in press, 45 research papers and articles, 15 chapters in books or monographs, one book and two patents. The research activities of the year's master's and doctoral candidates resulted in active external recruitment of all graduates.

Professional contributions by members of the faculty included organizing meetings and symposia. Four were held at Clemson University: Mathematical-Ecology Conference, S.E. Society of Parasitologists, the S.C. Aquatic Plant Management Society and the National Meetings of the American Society of Mammalogists. Other meetings organized by faculty included national and international symposia on: Regulation of Mineralization, Animal Migration and Orientation, and Facultative Sex Ratios and Sex Ratio Theory.

The following were among the other professional activities of the faculty: chairman, South Carolina Heritage Trust Advisory Board; president of the 3,000-member Animal Behavior Society; president and member of the Board of Scientific Advisors of the Highlands Biological Association; Board of Governors of the South Carolina Aquatic Plant Management Society; member of the university, state and district selection committees for the Rhodes Scholarship Trust; associate editors for the scientific journals *Animal Behavior*, *Transactions of the American Microscopical Society*, the *Journal of Experimental Zoology* and the *Journal of the American Killifish Association*; and editor for the three-volume treatise *Microscopic Anatomy of Invertebrates*.

Interaction with colleagues throughout the University and nation was a departmental priority. The department formalized a working relationship with researchers at the Greenwood Genetics Center. The departmental seminar series brought approximately 30 national and international scholars to campus for presentations and interactions. In addition a grassroots Ecology Seminar Series provided weekly interactions with scholars on and off campus. Creation of a departmental newsletter, *Biotype*, assured continuous

communication with the department's friends and colleagues throughout the state and nation.

The department has actively explored mechanisms to integrate its diverse research capabilities and interests. During the fall the department held a laboratory open house in which faculty shared the activities and facilities in the research laboratories. The department held its first retreat and organized into three informal research interest groups representing the areas of ecology/systematics and behavior, molecular biology and biochemistry, and organismal biology and physiology. Interest groups have become the focus for many activities, including the development of graduate curricula, student recruitment, and the development of research facilities and equipment grants. During the next year the faculty will look to maintain its intensity and enhance its reputation for excellence as it conducts an outside search for a new department head.

Biology

During the 1987-88 academic year, approximately 4,900 students were enrolled in courses in the Biology Program. Eight lecture sections and 61 laboratory sections per week were taught each semester by faculty and graduate students from the Biology Program and departments of Microbiology and Biological Sciences. Summer programs included an Advanced Placement Institute in Biology.

The Biology Program served as the regional center for the National Association of Biology Teachers Update for the second year. Seventy-five high school and college teachers from throughout the United States attended.

The Ninth Annual Clemson University Biology Merit Exam was conducted in April. Approximately 1,400 students attended.

Notable faculty activities included the award of a grant from the Fund for the Improvement of Post Secondary Education (FIPSE) for the development of process-oriented laboratories. One faculty member completed work on a \$184,000 National Science Foundation (NSF) grant for the development of computer software and has presented five workshops to disseminate the software, which will be published by Worth Publishers during the 1988-89 academic year. Three faculty participated in the Center for Excellence in Science and Mathematics. Projects led to the development of videotapes on subjects that are difficult to teach and to the development of telecommunications software. Two faculty members also participated in an IBM grant for evaluation of biology software for the high school classroom. One faculty member served as chief reader for the Advanced Placement Program with the Educational Testing Service and taught three national advanced placement workshops.

Additional activities included presentation of eight papers at annual meetings of the National Science Teachers Association, National Association of Biology Teachers and American Association for the Advancement of Science, review of NSF CSIP proposals and a paper presented at the National Conference for Minorities in Science and Engineering. Faculty also served as judges for the South Carolina Junior Academy of Science and local science fairs.

Eleven manuscripts were published, and three laboratory manuals were revised and published by faculty. Nine grant proposals and one renewal proposal were submitted during the academic year. Three proposals were unfunded, and six are still pending.

Chemistry

The Department of Chemistry continues to grow and prosper in the new Howard L. Hunter Chemistry Laboratory. The 1987-88 academic year saw a record number of undergraduates enrolled in freshman chemistry, with 3,200 registrations for the year. This large number of students presents a special challenge in providing quality laboratory experience. For most students at Clemson, chemistry is the first laboratory science they take. The faculty and graduate student laboratory assistants deserve much credit for meeting this challenge. Among many faculty, students and alumni of Clemson University, there is a widely held perception that the Department of Chemistry fails an inordinate number of freshman chemistry students. A recent five-year survey of freshman chemistry grades at Clemson under the unified program begun in 1983 shows that less than 10 percent of the students enrolled receive failing grades, and the distribution of grades in all freshman courses is consistent with national norms for similar comprehensive universities.

New faculty hired in the past five years continue to establish an impressive record. Five of these six have received major research funding, and three have received funding from the National Science Foundation, bringing the total number of NSF grants in the department to four. This is competitive nationally and ranks the department at or near the top of all academic departments at Clemson. Total new external funding committed to chemistry in calendar year 1988 will exceed \$1 million, which will be a new record for the department.

Dr. Ronald R. Williams joined the faculty as an associate professor in August 1988. Dr. Williams has been on the faculty at Ohio University where he has established a competitive program in analytical chemistry with research interests in the application of Fourier transform spectroscopy. His expertise in the use of computers in acquiring and processing analytical data will benefit many on-going research programs.

The Molecular Structure Center established in 1987 serves as a graphic example of how a commitment of funds in a critical area can provide considerable enhancement to research programs. Under the direction of Dr. William Pennington, the center has solved more than 60 molecular structures in the first year of operation, greatly enhancing the competitiveness of eight faculty in the department. At a one-time cost of \$180,000 for the instrumentation and the commitment of a new faculty position for the director (\$36,000/12 months), the near-term benefits in increased external funding make this an outstanding investment. The Department of Chemistry would realize a similar gain by establishing a center for nuclear magnetic resonance, which would require a \$300,000 initial investment.

The number of degrees granted for FY 1987-88 showed a slight increase over 1986-87 at the bachelor's level. However, the number of majors is growing in contrast to national trends, and larger increases are expected in the coming years. Bachelor chemists enjoy a strong demand for entrance into graduate schools and for employment in industry and government. At the graduate level, 20 M.S. and Ph.D. degrees were granted in the calendar year 1987, double the largest number of degrees for any previous one-year period. For FY 1987/88 there were seven M.S. and 11 Ph.D. degrees granted, compared to nine M.S. and five Ph.D. degrees for FY 1986-87. However a substantial

number of these advanced degrees are to foreign nationals, reflecting the competitive situation for attracting qualified U.S. nationals into graduate work in chemistry. Supply and demand have forced graduate assistant stipends to record levels across the United States. Those departments who cannot compete will be forced to admit mostly foreign nationals to survive. At Clemson we are marginally competitive and are maintaining the status quo, but we must find ways to become more competitive in the future.

The Distinguished Chemical Industry Business Seminar series celebrated its 10th anniversary in 1988. Organized by Donald L. Black, a retired vice president of Dow Chemical and adjunct professor in chemistry, the program has brought an outstanding list of executives to Clemson University to visit with faculty and students in chemistry and chemical engineering. To quote one of the participants, a president of a major petrochemical firm, "The Distinguished Chemical Industry Business Seminar at Clemson is an outstanding program — one of a kind. It provides an excellent interface between the University and industry and can be a major factor in orienting students and professors to the environment in industry." Mr. Black's contributions are an excellent example of how retired professionals are making major contributions to higher education.

Finally, chemistry is very proud of the special recognition given to two of its faculty during the year. Dr. Harold Garth Spencer, a member of the faculty since 1959 and a former department head, was named an Alumni Professor at Clemson for his excellence in teaching while maintaining an internationally recognized research program in polymer membranes. Dr. Darryl D. DesMarteau, department head, received the 1988 Drug Science Foundation Award for Contributions to Science in South Carolina and the Humboldt-Preise from the Alexander von Humboldt Foundation in West Germany for his research in fluorine chemistry.

Computer Science

The Department of Computer Science continued to make progress toward the establishment of a mature department with excellent research and instructional programs. This was the 10th year of the department's existence and the eighth year in which degree programs were offered.

The number of undergraduate majors continued to decline to about 280 in two B.S. programs. This is down from about 500 three years ago and is consistent with a national trend. Some further decline is expected, although enrollment in the entering freshman class seems to be stabilized at about 100 students. There were 94 B.S. graduates during the year, 35 in computer information systems and 59 in computer science. This is the largest number of graduates the department has produced in a single year, and in light of the declining number of majors, fewer graduates are expected in the next few years.

The graduate program continues to grow stronger. During the past year there were about 100 graduate students in the department, with about 18 of these being Ph.D. students. There were 23 M.S. graduates during the year, and the first Ph.D. degree in computer science was awarded in August 1987.

Employment prospects continue to be good for our graduates. The demand for graduates appeared to exceed the supply by a significant margin, and starting salaries

were significantly higher; however, there has been a shift toward more emphasis on academic performance in selecting candidates for positions.

A third problem area is recruiting high quality graduate students. We are again unable to compete with the support levels offered by our peer institutions. An increase in assistantship stipends and substantial fellowships is greatly needed.

Earth Sciences

The Department of Earth Sciences was established July 1, 1986. The department has seven full-time faculty members and offers the B.A. and B.S. degrees in geology. The baccalaureate curricula are designed to prepare geology majors for graduate study or for professional employment in private industry or government agencies. During 1987-88 five students were awarded B.S. degrees in geology.

An important part of the Department of Earth Sciences' educational mission is the teaching of introductory courses to Clemson undergraduates majoring in other disciplines. During 1987-88 introductory geology course enrollments were up by 254 students over the previous academic year, an increase of 67 percent. Also, three new courses were offered for the first time: Geology 210, Geology of the National Parks; Geology 220, Planetary Science (co-offered as Astronomy 220); and Geology, Selected Topics in Earth Science. The latter course was developed for middle school earth science teachers needing recertification and underscores an increased emphasis on providing continuing education courses for public school teachers.

The 1987-88 academic year was also marked by extensive planning to chart the future development of the recently established Department of Earth Sciences. In response to the growing national and regional demand for qualified hydrogeologists, the department has identified a program emphasis in groundwater geology and has proposed development of a Master of Science program in hydrogeology. This focus supports the emphasis on land and water resources management and environmental science that forms a vital part of Clemson University's Second Century Plan. A letter of intent concerning the proposed graduate program has been submitted to the South Carolina Commission on Higher Education, and the Master of Science proposal is now under preparation. The graduate curriculum for this degree will involve collaboration with the departments of Civil Engineering and Environmental Systems Engineering in the College of Engineering. Planning for a proposed merger of geology and atmospheric physics to form a modified department combining earth sciences and atmospheric sciences is also under study.

Noteworthy individual accomplishments of the Department of Earth Sciences' faculty during 1987-88 include the following: Dr. Howard Feldman, visiting assistant professor, published "Taphonomic Processes in the Waldron Shale, Silurian, Southeastern Indiana," presented a talk at the Geological Society of America (GSA) annual meeting in Phoenix, Ariz., and was co-author on two abstracts at the GSA Southeastern Section Meeting in Columbia, S.C. Dr. Vil Griffin, professor, was Clemson University's representative on the State Mapping Advisory Committee and coordinated Clemson University's contribution to a \$6,250,000 NSF grant proposal submitted by the University of South Carolina to establish a National Geographic Information System Center

in South Carolina. Dr. George Haselton, professor, presented an invited lecture on "Glacial Stratigraphy and Landforms in Central New Hampshire" at the University of Iceland. He also presented a poster session at the GSA Northeastern Section Meeting in Portland, Me., and was invited by the American Quaternary Association to lead a field trip in northern New Hampshire reviewing evidence for local mountain glaciation and for pulses of ice advance during the waning stages of retreat by the North American Ice Sheet.

Dr. Dave Snipes, professor, did extensive hydrogeologic field research at the Savannah River Plant (SRP) and contributed a lengthy chapter to the report "Geohydrology of the Defense Waste Processing Facility at the Savannah River Plant." This summer he was hired as a summer visiting scientist at SRP. Mr. John Wagner, assistant professor, received grants from the Kellogg Foundation and NSF/South Carolina Professional Development Program. He published a slide/tape learning module on "Erosion and Land Management in Upstate South Carolina," co-authored two abstracts at the GSA Southeastern Section Meeting in Columbia, S.C., and gave seminars to the South Carolina Science Council and South Carolina Earth Science Teachers Association. Dr. Richard Warner, associate professor, was co-author on a paper, "Magnetic Petrology of Deep Crustal Rocks — Ivrea Zone, Italy," and was the recipient of two travel grants from the Southern Regional Education Board to use the Southeast Regional Electron Microprobe Facility at the University of South Carolina. Dr. Warner served as acting head of the Department of Earth Sciences for a second year in 1987-88.

Mathematical Sciences

During fall 1987 the student credit hours generated by courses taught by Mathematical Sciences Department instructors increased over 10.5 percent from fall 1986. In excess of one-eighth of the fall 1987 student credit-hour generation of the entire University was generated by registrations in mathematical sciences courses. In terms of FTE students, the Mathematical Sciences Department is comparable to a small college with 1,564 students. Thirty-seven mathematical sciences majors received baccalaureate degrees, 20 received masterial degrees and four received doctoral degrees in graduation exercises of 1987-88.

After 10 years as department head, Dr. John D. Fulton resigned effective August 15, 1988, to assume the position of dean of arts and sciences at the University of West Florida. After a nationwide search, Dr. Richard D. Ringeisen, currently Clemson University professor of mathematical sciences and a former associate head of the department, has been named as his successor.

In August 1987 one new faculty member joined the department to replace one professor who retired the previous June 30. On June 30, 1988, three others retired, including one who has been department head, the first dean of the College of Sciences and department leader in graduate education. Another of the retirees was for many years the director of the University Computer Center. Five new faculty joined the department in August 1988.

One faculty member has been chair of the Academic Council of the College Board, is director of the AP Readings for the Educational Testing Service, has been governor

of the SE Section of the Mathematical Association of America and recently assumed the position of program director for Calculus Programs for the National Science Foundation. Another was elected to Fellowship in the Institute of Mathematical Statistics. Two won prizes for best papers in two different research journals. An emeritus member of the faculty was named Outstanding Mathematics Educator by the S.C. Council of the Teachers of Mathematics. A faculty member was elected a director of the Classification Society, and another was elected president of the S.C. Chapter of the American Statistical Association. One faculty member received a special commendation for research from the director of the national Supercomputing Research Center. Another is managing editor of a research journal, two serve as associate editors of research journals and three serve on editorial boards of research journals.

Department faculty completed their second year of research activity under the Department of Defense's five-year Office of Naval Research contract in the University Research Initiative Program. Contract funds have enabled the purchase of eight nodes of a 16-node hypercube mathematical sciences parallel processing computer for the University as well as considerable peripheral equipment. Contracts and grants in force of the department amount to approximately \$4 million while research and development expenditures for 1987-88 amount to approximately \$1.2 million. Part of this grant activity includes University-level support for mathematics education through a three-year Center of Excellence Grant in mathematics and science education, a mathematics education grant funded through the Education for Economic Security Act and a mathematics education project funded as a part of a grant to South Carolina by NSF.

Departmental faculty are participants in the University Center for Computer Communication Systems and in research foci in distributed systems and in biotechnology. Some participate in the Clemson Apparel Project funded by the Defense Logistics Agency.

Through teaching, research and service, faculty of the Mathematical Sciences Department are major contributors to the advancement of the reputation of Clemson University.

Medical Technology

The Medical Technology Program completed another productive year of teaching, advising, administrative activity and club sponsorship. The program currently enrolls about 30 students. Five entering freshmen and seven transfer or change-of-major students joined the medical technology curriculum. This was offset by 12 students transferring out of the program. In addition five students completed the baccalaureate degree requirements for graduation. Our senior clinical-year students continue to excel on the national certification exam. All have been successful in finding employment in the profession.

Senior-year clinical courses continue to be offered by hospital program affiliates. Our formal affiliation programs are with the schools of medical technology at Anderson Memorial Hospital in Anderson, S.C., and at McLeod Regional Medical Center in Florence, S.C. Informal affiliations exist with the medical technology programs at the Medical University of South Carolina in Charleston and the Baptist Medical Center

in Columbia, S.C. This year two rising seniors were accepted by and chose to attend the nearby Anderson Hospital program, and one chose to attend the clinical program at the Medical University. The Anderson program continues to help teach the introductory medical technology course taken by new majors.

With the advent of government restrictions limiting health-care reimbursements to hospitals and other providers, many hospital-based programs in health education need to develop additional sources of funding for fiscal stability. Through the Medical Technology Committee, the University has instituted a plan whereby Clemson University provides a significant amount of support to the Anderson Hospital School of Medical Technology for each Clemson clinical student in attendance in return for a guarantee of eight places in the class.

The current program coordinator continued to promote medical technology by group and individual presentations to students and teachers from around the state and by participation in the spring annual meeting of the South Carolina Society for Medical Technology.

The student Medical Technology Club completed another successful year of activities including trips to the Greenville Memorial Hospital laboratory and to the Atlanta Red Cross Blood Center, presentations by speakers and service projects.

Microbiology

Ninety students were enrolled in the B.S. degree program, 26 in the M.S. and 17 in the Ph.D. Throughout the year 31 students graduated with the baccalaureate degree, nine received the master's and four the doctorate. Ten undergraduate majors were named to the President's List and 31 to the Dean's List. Some B.S. graduates accepted positions with industries, while others began graduate programs or entered medical schools. The Microbiology Department continued to provide the largest percentage of Clemson graduates admitted to medical schools. Master's graduates either continued with doctoral programs or obtained employment in the business sector. One Ph.D. graduate was commissioned in the U.S. Army, and the other three accepted post-doctoral positions at St. Jukes Hospital Research Center, University of Miami Medical School and the University of Maryland.

Faculty continued to pursue a wide variety of research projects and obtained \$700,000 of external grant and contract funds to support their activities. Sources included USDA, Food Science Corp., Monsanto Co., U.S. Geological Survey, NIH, NIDR, ERDC, Dow Corning and the U.S. Army. The most significant research project was the release into soil of a genetically engineered bacterium in a field test. This was undertaken to establish the feasibility of using genetically engineered bacteria for agricultural purposes. This was a joint project with the Department of Agronomy and Soils and the Department of Plant Pathology and Physiology in the College of Agricultural Sciences. Funding was provided by the Monsanto Co. This is a landmark in that it is the first U.S. field testing of a recombinant DNA-engineered bacterium. The project has received both national and international notoriety and has served as the University's lead biotechnology project.

Other projects undertaken in the department have been: the effects of pesticides on microbial activities in aquatic sediments; the microbial degradation of herbicides in anaerobic aquatic sediments; biological nitrogen fixation by a halotolerant bacterium that associates with sea grass plants; diseases of catfish and their immunological response; the role of certain bacteria in one form of arthritis; chemical stimulation of the immune response; development of monoclonal antibodies and DNA-probes for pathogenic mycoplasma; the genetics and control of cellulose enzyme production; effective conversion of residual cellulose in extracted alfalfa to sugars; genetic engineering of rhizobia for improved biological nitrogen fixation; genetic engineering of lactic acid bacteria for improved food processing and production; enhancement of amino acids and vitamins production by a strain of *Escherichia coli*; hormonal control of DNA expression in mouse melanoma cells; regulation of procaryotic and eucaryotic DNA expression by low molecular weight metabolites; isolation and characterization of oncogenes; interactions of chemical carcinogens with DNA repair of UV-damaged DNA; interaction between methanogenic and sulfidogenic bacteria; characteristics of the cellulose complex produced by a salt marsh bacterium; and microbial aspects of cotton dust as related to brown lung disease.

Faculty published 25 journal articles, made numerous presentations at state, national and international scientific meetings, and served in many professional capabilities. Highlights were two presentations by Dr. Ellis Kline: one to the S.C. Legislature explaining Clemson University's efforts in biotechnology, and a presentation on the future of biotechnology to members of the U.S. Congress. Other presentations were those describing biotechnology projects at Clemson University made to the USA-Japan Committee for Promoting Trade Expansion and to a Japanese delegation from the city of Hiratsuka, headed by Mr. Kono, the former Japanese minister for science technology. The department also organized the Second Annual International Bioprocessing Conference, dealing with mammalian cell culture, held in Atlanta. The third conference is being planned.

The department has played an important role in the biotechnology activities of the University, and these efforts are being expanded and developed.

Physics and Astronomy

This has been a year of transition in the department. Dr. Skove spent the year in Washington, D.C., where he served as a program director for the Materials Research Division at NSF. Dr. Lewis Duncan was on leave at Stanford University. He and astronaut Sally Ride were the two Carnegie Science Fellows at the Center for International Security and Arms Control. The retirement of three members of the faculty — Drs. Bookmyer, Chaplin and McKelvey — coupled with leave for Drs. Duncan and Skove brought five new but temporary faculty on board. These temporary faculty served us well as they contributed to our instructional and research programs.

Dr. Chaplin, although retired, maintains a research program in radiation damage recovery, and he received renewed support from Martin-Marietta. Dr. Duncan has a NASA contract for his investigations of plasmas in the upper atmosphere. Dr. Larcom obtained funding from NIH for his work on the repair of genetic damage. Dr. Larsen's

NASA grant was renewed as he continues his studies of winds. Dr. Ulbrich was awarded a new NSF grant for his radar studies of precipitation and storms. Travel grants were awarded to Dr. Burt (NATO) and to Dr. D. P. Miller (NSF). Dr. Manson received support from the Kernforschungsanlage at Julich, West Germany, for his work there. Drs. Gettys, Turner and Vogel were funded from the CHE Center of Excellence in Mathematics and Science Education grant. Drs. Graben and Larcom received Provost Research Awards.

Long-held hopes for an Astronomical Observatory at Clemson are now being realized with the selection of a site south of the main campus. The area should provide excellent viewing conditions because the surrounding forest and pasture land is free of sources of light pollution. The observatory will be developed as a teaching, research and public service facility by this department in association with the Clemson Area Amateur Astronomers.

Among other noteworthy events during the year was the designation of Dr. Larsen as the Sigma Xi Outstanding Research Scientist. He was honored for his optical and radar studies of winds in the atmosphere. Dr. Ray was one of four plenary speakers at a memorial conference for the late A. Rahman at the University of Minnesota. Dr. Laskar's proposal was approved to organize and direct a NATO Advanced Study Institute on Diffusion in Materials. The institute will be held at Aussois, France, in March of next year. Serving as chief reader for Advanced Placement Physics, Dr. Gettys supervised the reading of more than 12,000 AP physics examinations. A \$25,000 gift from Ms. Anne Landsman established the Herbert R. Isenberger Endowment for Physics. Income from the endowment will be used to provide one or more fellowship supplements for graduate study in this department.

For the coming year, two new faculty and a new department head will be joining us. Dr. Robert Panoff, whose research is in quantum Monte Carlo methods, comes from Kansas State University. Dr. G. X. Tessema comes from Memphis State University by way of Grenoble, France. His research is on charge density waves. Dr. Peter McNulty has accepted the position of department head, thus ending a two-and-a-half-year search. He comes from Clarkson University, and his research has been focused on radiation effects on integrated circuits, particularly in a space environment. Dr. Duncan returns from Stanford to become the associate dean for research in the College of Sciences.

DIVISION OF AGRICULTURE AND NATURAL RESOURCES

The Division of Agriculture and Natural Resources is responsible for instructional, research and public service programs in the College of Agricultural Sciences and the College of Forest and Recreation Resources.

In addition to its programs for resident instruction, the College of Agricultural Sciences administers statewide public service programs that serve businesses, industry and virtually every citizen of the state. These public service functions include administration and coordination of the S.C. Agricultural Experiment Station, the Clemson Co-operative Extension Service, the Division of Regulatory and Public Service Programs

and the Livestock-Poultry Health Department. The scope of the College of Forest and Recreation Resources' programs also spans the entire state and touches the lives of all South Carolinians through teaching, research and Extension activities in forest management, wood utilization, recreation resources and services, and tourism management. During their past century of service to the state, the agriculture divisions and their leaders have emphasized agricultural production and improved family life, thus laying a strong foundation for the next century. As we have celebrated the University's second century, our objectives have been to increase productivity, increase employment opportunities, and conserve and protect our natural resources.

In the past year, our research efforts in the area of biotechnology took a quantum leap forward with the progress of the landmark field test at the Edisto Research and Education Center in Blackville. The first phase of the 18-month field test convinced researchers that genetically engineering microorganisms can be effectively monitored and their movement closely tracked after they are released in the environment. The positive results of this field test will certainly pave the way for more research in biotechnology.

Construction began this year on a new research facility at Clemson where the effects of acid rain and other atmospheric pollutants on tree growth will be studied. The construction is being funded by a major research grant awarded in the previous fiscal year to the College of Forest and Recreation Resources by the U.S. Environmental Protection Agency. Over \$1 million was appropriated for the research project and the facility, which will feature 24 greenhouse chambers and numerous labs and offices where the problems of acid rain will be studied.

A \$1.1 million grant was awarded to Clemson University from the W.K. Kellogg Foundation of Battle Creek, Mich., to revitalize South Carolina's rural communities through local leadership development. The three-year project, to be coordinated by the Clemson Extension Service, will bring together a broad range of Clemson University resources and leadership development services available through other organizations and agencies. Its aim is to select four pilot counties in the state, and through leadership development, help these communities toward economic recovery.

More detailed reports of each of our divisions follow.

COLLEGE OF AGRICULTURAL SCIENCES

Agricultural Instruction

The College of Agricultural Sciences satisfies the mandate of the will of Thomas Green Clemson, "to afford thorough instruction in agriculture and the natural sciences connected therewith....," through the 17 undergraduate curricula and master's and doctoral programs administered by the college.

Agriculture is an increasingly complex, dynamic, professional field. Worldwide, agriculture is the major force in alleviating undernourishment and malnutrition. In the United States, agriculture is a major positive factor in the balance of trade and accounts

for up to 20 percent of the nation's employment. Remarkably, less than 3 percent of the population is directly involved in the production of crops and livestock. In South Carolina the agricultural industry generates up to \$3 billion annually in the state's economy, including crop and livestock production (about \$1 billion) and all aspects of value-added industries such as food packaging and processing.

South Carolina's agriculture is changing. Food manufacturing, processing and packaging are rapidly expanding industries along with the production of ornamental plants and turfgrass. Traditional crops and livestock remain important to the state's economy. Agricultural graduates are prepared to serve this major industry in the state, the nation or worldwide.

Recognizing problems and applying basic principles to finding solutions is a fundamental element of undergraduate education in agriculture. Problem recognition/solving skills are stressed along with the mastery of a body of current information. Developing skills in five broad areas forms the foundation of undergraduate curricula: communications, business, people management, basic sciences and a field of technical agriculture.

The basic structure and philosophy of the land-grant institution — the emphasis on practical service and the association of teaching, research and extension in a common administrative unit — help ensure students are exposed to the most current facts and theories, as well as to problems, issues and controversies. The classroom teacher is also a research scientist or Extension specialist. In addition, students benefit from equipment and facilities associated with research responsibilities.

Instruction comes to its closest interface with research in graduate education. Graduate students contribute significantly to the research efforts of the college, and growth of the graduate program reflects maturity of the college and University. The graduate programs in Agricultural Sciences are facing several serious problems. Serious needs for equipment in all areas are being addressed. The number of potential students is approaching an all-time low, and nationwide competition for students is intense. Financial support for graduate students is a serious issue limiting programs. In 1987-88 graduate programs were reviewed by the S.C. Commission on Higher Education. This review resulted in suspension of admissions to the Master of Agriculture program. The problems are being addressed by a faculty committee, and reinstatement of the program is anticipated.

Teaching faculty continue to be active in a variety of professional programs and activities that stress teaching. Professor Mary T. Haque was recognized as the Outstanding Horticulture Teacher in the United States in 1987-88. The college has entered the age of modern program delivery with courses being prepared for instructional television via Telecampus.

Recent trends in enrollment declines have reversed. This is a reflection, in part, of recruiting efforts over the past several years and of a better image of agriculture in recent years. A new, intensive correspondence effort using PSAT scores for more than 1,500 South Carolina high school students has been initiated. This is very time consuming and results will be evaluated. High school visitations will remain the central element of active recruiting. The serious problems affecting the nation's agriculture in 1988 may have a negative effect on enrollments in 1989.

International Agriculture

The University assumed many responsibilities for international programs in 1987-88. The college continues to serve international students at all degree levels as well as faculty exchanges. No new programs have been initiated, although several faculty have formalized arrangements for foreign assignments in the coming year, and a variety of foreign visitors have been scheduled.

Continuing Education

In addition to the numerous programs provided through Extension, a variety of short courses, workshops and seminars are presented through continuing education efforts. These programs are designed to assist all phases of agriculture. Several programs have become essentially permanent, including the nematode short course and the bankers short course. In 1987-88 policy was modified to allow CEU's to be awarded for selected, Extension in-service training programs.

In all program areas, the college is still adapting to recent changes in administrative structure and personnel. The commitment is to maintain the record and reputation of superior service to agriculture.

SOUTH CAROLINA AGRICULTURAL EXPERIMENT STATION

The South Carolina Agricultural Experiment Station at Clemson conducts the state's only state-funded agricultural research program. Scientists in 12 departments of the College of Agricultural Sciences provide expertise for this program, while home economics research is conducted at Winthrop College.

Facilities at Clemson and at four research and education centers located across the state provide indoor and outdoor laboratories for scientists in agricultural economics, agricultural engineering, aquaculture, fisheries and wildlife, agronomy, animal science, dairy science, entomology, food science, horticulture, plant pathology and poultry science.

Branch research and education centers are Edisto at Blackville, Sandhill at Pontiac, Pee Dee near Florence and Coastal near Charleston. The Simpson Experiment Station near Pendleton also serves as an outdoor laboratory for researchers and faculty at the University campus.

Researchers at these regional centers conduct studies and carry out experiments relating to growers and crops in their respective geographic areas under constraints and conditions of different soils and climates.

During this fiscal year the Experiment Station celebrated the 100th anniversary of the signing of the Hatch Act, the legislation that provided federal funding for state agricultural experiment stations. South Carolina's Experiment Station was created by Congressional Act in 1886 and is state controlled and funded with annual appropriations from both the South Carolina General Assembly and Congress.

In all 50 states, experiment stations conduct both cooperative and complementary research. They avoid duplication of efforts and build on the foundation of information which has been primarily responsible for advances made in agriculture during the past 100 years.

To meet future challenges, the South Carolina Agricultural Experiment Station will continue to produce new research findings to add to those of its counterparts across the country in meeting a common goal — creating better standards of living for people through the wisest and best use of natural resources.

The following summary is a capsule review of the extensive research program at the Experiment Station. Many important studies may have been omitted, and those that follow are intended only to illustrate the scope of the Station's total program.

Agricultural Economics and Rural Sociology

The research goals in this department are: to enhance quality of life by giving policy makers scientifically based information; and to improve economic well-being in local, regional, national and international economic sectors, particularly agriculture and rural areas. Our research is focused on contemporary issues and problems.

Two economic models are used to estimate the cost to consumers of U.S. sugar policy. A market model allocates industrial and nonindustrial sugar use, corn sweetener use and sugar imports according to conventional demand schedules for consumption requirements. A mathematical programming model is used to simulate trade patterns among the major sugar producing and consuming regions of the world. Particular attention is paid to the United States, the European community, the nations included in the Caribbean Basin Initiative and those associated through the Lome' Agreement. Multiplier analysis reveals that an increase of one cent in the U.S. raw sugar price objective — the principal policy signal — induces increases of about 7,500 acres of sugarbeets and about 2,600 acres of sugarcane. The same one cent drop in the price objective leads to reductions of 115,000 tons in industrial sugar use and 105,000 tons in nonindustrial sugar use. Wholesale and retail sugar prices rise by 5.2 and 5.6 cents per pound, respectively. Corn sweetener prices rise by nearly one cent per pound and corn sweetener use falls, but by a very small amount.

Use of marginal cost pricing rules was found to be a feasible management tool for selected S.C. water utility systems, which would encourage long-run efficiency in water use. Water transfers between basins were found to be an attractive alternative to high cost water recovery systems within the basins under some conditions of supply and demand elasticities and water transfer costs. Use of a benefits-received principle for cost sharing to preserve pristine beachfronts in S.C. was recommended in order to establish special taxing districts for beach nourishment.

A state-regulated monetary bank for pooling infrastructure loans by S.C. communities was proposed and passed by the S.C. General Assembly. This provides a means to foster development in rural areas and small communities of the state. National and regional trends point toward the need to recognize the role of small business development in rural South Carolina. Regional cooperation and use of cost/benefit analyses to target government investment and incentives for rural development programming were proven to be beneficial in rural South Carolina.

Linear programming techniques are used to construct a model providing for competition among firms at the regional level and among enterprises at the firm level. The model includes: seven tobacco production activities representing technology and scale of operation; crops — corn, soybeans and wheat; livestock — cattle and swine; and resources — buying and selling of quota, off-farm employment, labor, etc. The model utilized data believed to represent conditions in 1984. Benchmark application indicated increases in corn production and slight decreases in soybeans and feeder-pig production.

Results indicate that in the long-run, approximately 156 million pounds of tobacco are marketed at a price of \$1.39 per pound. The gains to producers with mechanical harvesters, \$11.6 million, and the loss to producers with non-mechanical harvesters, \$32.2 million, is substantially more in the long-run. Results also show that any reduction in the support price or in tobacco quota will reduce farm income substantially. Also, the loss to the producers under the different policy scenarios are lower if a new crop, such as vegetables, can be produced and marketed with the resources freed from tobacco production.

The purpose of this study was to provide an analysis of the problems associated with market entrance and market share expansion at the wholesale level in the fresh produce industry. Of particular concern were price and nonprice incentives on the buying behavior of the integrated retail-wholesale buyer. Empirical results indicate that the important marginal factors that increase the probability of buying from a new supplier are the physical quality of the product and providing a consistently uniform pack. Factors having an important negative marginal influence on the likelihood of buying from a new supplier are a buyer's use of an established supplier. The more a buyer uses established suppliers, the less likely he/she is to buy from a new supply source. Additionally, the relative strength of the nonprice incentives as a competitive tool increases as this factor becomes more important. The reverse occurs when the buyer is unable to use established suppliers. In this case, the likelihood of buying from a new supplier increases, but his/her responsiveness to changes in the various nonprice incentives is reduced. Price has little, but not zero influence on the probability of buying from a new supplier.

Agricultural Education

The Agricultural Education Department is participating in a regional project to analyze the labor force experience and continuing education of college graduates in agriculture. During 1987-88 a comprehensive code book was developed for consistently coding the 12-page questionnaire data across the region. The 155 Clemson questionnaires were coded, and the data were entered into the computer for analyzing and processing. The South Carolina Station's data set was forwarded to the technical committee chairman for creating a regional data set.

Agricultural Engineering

The mission of the Agricultural Engineering Department is to conduct research for the production and processing of food and fiber in an economical and environmentally sound

manner. There is a wide range of research projects under way to address this mission. The primary tasks of research are: power and machinery, food and process engineering, electrical and electronic systems, soil and water, structures and environment, waste management and aquaculture. Two of the approximately 40 projects are highlighted below.

The development of techniques for estimating and controlling erosion from agricultural watersheds remains a high priority. The complexity of the erosion process requires a multi-faceted design approach. Runoff rate and sediment concentration samples are collected during runoff events from nine 0.4 acre plots located near Clemson. Comparison of runoff, sediment yield and crop yield is being made from bottom plowed, chisel plowed and no-till treatments.

Data from sites irrigated with center pivot irrigation equipment are being collected from plots located in Newberry County to compare furrow-diked areas with non-diked ones. Furrow diking is a technique to make small barriers or dams perpendicular to the corn or soybean row. During rainfall these dams reduce or prevent the water from running off a field. Runoff is measured using a computer-based data acquisition system. Tensiometer data are collected to monitor soil moisture content. Substantial reduction in runoff volume from both rainfall and irrigation has been demonstrated where furrow dikes are installed. Computer modeling of erosion and runoff is being utilized allowing optimal strategies to be developed for their control. The Clemson University Rainfall Simulator and a surface profiler will be used to determine surface retention and failure conditions of the dikes, facilitating improved modeling of the furrow dike system. Image processing is being studied as a means of crop cover. Effort has also been initiated to determine sediment concentration, size distribution and fraction of aggregates in runoff. This work also utilizes image processing and holds promise for quantifying these parameters on a near real-time basis. Successful implementation of these techniques would directly benefit water treatment personnel, monitoring agencies, and sediment control researchers and would eventually help to reduce soil erosion.

Energy required for producing crops in the United States accounts for only 3 percent of the total energy consumed. However, cost of energy utilized is of considerable significance to farmers' profit, so they must be energy efficient. Tillage systems require large amounts of energy in the form of fuel for tractors. Agricultural engineers have developed tractor-mounted, computer-based instrumentation systems for rapidly measuring forces, speed, wheel slip and fuel consumption during tillage operations. Studies with these systems have documented the power and fuel requirements and the yield returns from tilling at different depths. It has been found that by subsoiling into the clay layer in many of S.C.'s coastal plains soils, yields of soybeans can be increased by five to 15 bushels per acre. Subsoiling to the proper depth may require only a half gallon per acre more diesel fuel than operating at the shallow depth. Detailed knowledge about the costs of and returns from production operations can help farmers make correct management decisions.

Agronomy and Soils

The Agronomy and Soils Department conducts research directed toward the most efficient use of soil resources for agricultural production and preservation of environmental quality. It also conducts research in management of agronomic cropping systems and in development of new crop varieties.

Research on the ecology of weeds has moved forward on three fronts. Agronomists continue to search for practical ways to manage herbicide-resistant biotypes of cocklebur and goosegrass. Although they are difficult to control, the resistant biotypes do not appear to be stonger competitors for space, nutrients and water than their non-resistant counterparts.

Research on weedy cowpeas, a problem in production of certified soybean seed, has shown that proper timing of Chlorimuron when combined with other standard practices offers satisfactory control of the pest. *Palmer amaranth*, often confused with Smooth pigweed, has been found to be more resistant to herbicides due to rapid growth in the seedling stage. Effective control will require earlier treatment than is practiced for its look-alike.

In the forage area, the problem of fungus-infected pastures has caused considerable economic losses in the state and throughout the Southeast. There is an apparent instability to populations or pastures with a low degree of infection. It is considered a community evolutionary process. Current research is attempting to identify the causes of the gradual rise in degree of infection that results in highly infected pastures and associated livestock problems. Current findings show that when the degree of infection is low, livestock can discriminate in favor of non-infected plants. Also, infected plants produce more seed — as much as 40 percent more — than non-infected plants. The evolutionary process is being studied with low and high infected populations of fescue that have been established.

A new variety of cotton, PD 3, was released by the USDA-Clemson team working at the Pee Dee Research and Education Center. This cotton variety has superior fiber strength. Its overall fiber qualities are excellent, and it shows a healthy resistance to root-knot nematodes. In most years it will produce cotton comparable to that produced in the San Joaquin Valley of California. It is expected to bring a premium price at the mills and should help South Carolina's cotton producers maintain a competitive edge.

A new Station bulletin was published which synthesizes about 20 years of research in soil fertility. The document contains databases relating to lime and fertilizer responses for some of the major agronomic crops grown in the state. These databases provide the technical insight for Clemson's lime, fertilizer and soil test recommendations.

The Cooperative Soil Survey Program, a joint activity with the Soil Conservation Service, is 95 percent completed for the state. All but two counties, Hampton and Chesterfield, have been mapped; these two are 50 percent completed.

The department has completed its sample assessment for the Direct Delayed Response Project, a new facet of the national program of assessment of acid precipitation. Research on soils of the Blue Ridge region of the state has discovered relatively young soils with large amounts of gibbsite. Previously, pedologists believed that large amounts of gibbsite in a soil was an indication of old soils subjected to extensive weathering. This finding will require a reassessment of theories on soil weathering and mineralogy.

Animal Science

Research in the Animal Science Department has determined that a fungus, *Acremonium coenophialum*, in the tall fescue plant tissue causes numerous reproductive problems in mares grazing tall fescue such as prolonged gestation, thickened placentas, weak or dead foals, and lack of milk production. Additionally, it has been determined that ingestion of fescue contaminated with the fungus causes lowered blood levels of the hormones prolactin, estrogen and progesterone. Current research also has shown that gravid mares that are at or past their normal gestation length return to near normal and foal in approximately six days after withdrawal from fungus-infected pastures. In another study, beef heifers grazing fungus-free pastures gained .52 pounds per head per day more than those grazing fungus-infected pastures, which denotes a 43 percent increase in growth.

A new concept in pig nursery designs has been developed and evaluated. This nursery is a monoslope building, with its long axis oriented east-west and its high wall facing south. The south wall has a large area of windows that allow for significant solar gain when closed and significant ventilation capabilities when opened. The nursery is not insulated and is ventilated only by natural means. Within the nursery, a miniature "ideal" environmental area is provided to each pen of pigs. That environment is created inside an insulated brooder box, which the pigs may enter when cold. Within this brooder box, air heated to 80 degrees is circulated underneath the floors. Energy savings are apparent since only 3 percent as much air is heated as with a conventional nursery, plus no costs are incurred in operating the ventilation system.

Prostaglandins are fatty acids produced in every tissue of the body and are involved in blood clotting, inflammation, pain and regulation of the immune system. Research in the department with one of these prostaglandins, prostaglandin E2 (PGE2), in the pig has shown that PGE2 may also play an important role in helping to maintain pregnancy after fertilization occurs.

PGE2 seems to protect pregnancy through an antiluteolytic effect, by preventing the regression of the corpus luteum in the ovary, thus helping to maintain the production of progesterone, the hormone of pregnancy. This research will help in understanding the mechanisms that regulate pregnancy maintenance, and, therefore, eventually result in a more efficient management of reproduction in farm animals.

In bull fertility research, 862 yearling beef bulls were subjected to a complete breeding soundness examination (BSE) at completion of performance testing programs. Of all bulls, 80.1 percent were classified satisfactory potential breeders (S), 7.3 percent questionable potential breeders (Q), and 12.7 percent unsatisfactory potential breeders (U) as defined by the Society for Theriogenology. This study is the first to incorporate the Society for Theriogenology guidelines into evaluating any number of yearling bulls for fertility. Adjusted mean scrotal circumference (SC) measurements were 31.0, 33.2 and 34.8 cm, respectively, for bulls classified U, Q and S ($P < .01$). The significant fact is that 20 percent of these yearling bulls might have been sold as breeding bulls when in actuality they were not satisfactory from a fertility standpoint.

Angus and crossbred cows were studied to determine the effects of dam breed, sire breed, nutrition level and other factors upon pregnancy rate. Over a 10-year period,

the level of nutrition had a highly significant influence upon pregnancy rates, but there were no dam breed X level interaction. Sire breed, dam age and dam breed did have a significant influence upon reproduction. Calf birth weight did not affect rebreeding, but cows that required assistance were less likely to rebreed. Cows that failed to rebreed for the first time as 2-year-olds through 8-year-olds had a probability of repeating a miss within a year of 15.9 percent, 13.4 percent, 15.0 percent, 14.9 percent, 41.2 percent, 5.6 percent and 8.3 percent respectively.

Aquaculture, Fisheries and Wildlife

South Carolina's wintering waterfowl population has declined dramatically over the last 10 years. One of the efforts initiated by the S.C. Wildlife and Marine Resources Department to counteract this trend has been the non-migratory Canada goose release program. To determine the biological impact of this program, a cooperative study between Clemson University and the S.C. Wildlife and Marine Resources Department was conducted to evaluate Canada goose nesting biology and gosling survival on a large reservoir where over 500 adult geese were released. This study revealed that geese were readily nesting and producing an abundance of young. However, almost all goslings succumbed to predation within one-two weeks after hatching. Therefore, state wildlife biologists are altering their management plans to reduce gosling predation on this reservoir.

Commercial crawfish farmers typically manage culture ponds for a spring harvest. Some crawfish operations have considered extending the harvest season into the summer to take advantage of lessened competition among producers and a more favorable price structure. Culture ponds at Clemson were used to evaluate crawfish and forage production in experimental units managed on a typical (control) and extended schedule over a two-year period. In the first year of production (1986-87), control ponds had approximately two times the amount of forage (rice) as those managed under the extended schedule. However, crawfish production was statistically similar in the two management strategies. Harvests averaged 1,070 pounds per acre and 765 pounds per acre in the typical and extended management ponds, respectively. Crawfish produced in the control ponds were larger than those harvested from ponds managed under an extended regime. Overall rice forage production was higher during the second production year (1987-88), but no statistical difference was detected between management regimes. Crawfish production decreased during the second production season to 725 pounds per acre in the control ponds. A detailed comparison of crawfish production in both types of ponds will be done after harvesting is completed.

Other studies have been directed toward improving methods of culture. For example, a competitive study was conducted at the aquaculture facility to increase efficiency of multiple cohort-stocked catfish. By using an excluder, small fish had increased growth of 59 percent over fish in control ponds. Diets with four different protein percentage levels (28, 32, 36, 40) were fed to catfish in cages. The 32 percent diet appeared to get growth and conversion rates as good as 36 percent or 40 percent with a feed conversion efficiency of 1.45:1. It appears that catfish grown in cages perform comparably to catfish grown in open pond systems.

Catfish stocked in cages were marked at three specific sizes. The marked fish maintained light grouping with respect to frequency distribution, which suggested that a reduction in variability at harvest can be accomplished by reducing variability at stocking.

Dairy Science

Research interest in the use of a sustained-released bovine somatotropin (BST) on lactation, reproduction and health of dairy cows continues. A second year efficacy trial and three field trials are under way. Data from the efficacy trial continue to support increased milk production and improved feed efficiency. No health problems or reproductive disorders have been associated with use of BST. Field trials in commercial herds are to date in agreement with the efficacy trial data.

Feeding of hydrogenated tallow to dairy cows is being investigated. The acceptability and digestibility of this product if acceptable would make use of large quantities of used cooking oils from fast food restaurants. The tallow mixes well in a complete ration, and the cattle consume it well. Digestibility data are being analyzed for possible decisions on potential importance of this product.

Reproducible in vitro culture techniques for bovine monocytes and macro-phages have been established. It has been determined that phages incorporate 10 percent of an H-labeled dose of aflatoxin B1 into the cell.

A comparative study of calf and shark liver metabolism revealed that nurse shark liver does not significantly activate aflatoxin B1 to a DNA-binding metabolite. Calf liver metabolite profile reveals small amounts of the tris-diol adduct while little, if any, similar adduct could be obtained from shark liver. The objective of in vitro culture is to support embryonic development during the stages prior to attachment in the uterus. Consistent results are not achieved when bovine serum albumin is used as the serum source. Therefore, commercially prepared serum replacements are being evaluated for use in vitro culture systems for murine, ovine and bovine embryos. Non-specific growth factors (Somatomedin-C and Epidermal Growth Factor) are being used in the in vitro culture systems to determine any growth-promoting effects. Embryos (day 6 to 8) are being processed for ultrastructural comparisons with embryos developed in vivo. Results of these studies will advance the understanding of the requirements for in vitro embryonic development. Through these studies, more successful embryo transfers and ultimately genetic improvement could be achieved.

Preliminary data suggest that consumers can significantly distinguish between sherbet produced with carbon dioxide and a similar product frozen with air. Although they preferred the non-carbonated product, the preference may be due to bias caused by the same sherbet. Initial research suggests that soft serve frozen dessert machines require major changes to produce such a product. Industrial equipment is needed to carefully control overrun primarily caused by the high solubility of carbon dioxide in frozen dairy dessert mixes. Some traditional frozen dairy dessert flavors have been found to be incompatible with carbon dioxide.

Entomology

Caterpillars that make up the bollworm-budworm complex are major pests of all important row crops in South Carolina including corn, cotton, tobacco, peanuts and soybeans. Studies of the naturally occurring diseases that help regulate populations of these pests have led to the discovery of two previously unknown diseases, a virus and a fungus, that can significantly reduce pest populations. A better understanding of when and under what conditions these two diseases occur can lead to the development of more effective pest management systems for this pest complex and a reduction in the need for pesticide applications.

Scientists in entomology, agronomy and plant pathology are breeding South Carolina soybean cultivars that show resistance to major insect and nematode pests. Adequate levels of resistance have been found to be the state's most serious soybean insect pests including corn earworm, soybean looper and velvetbean caterpillar. Cultivars developed in other geographic locations (Georgia, Florida, Louisiana, Texas, North Carolina and Mississippi) have been tested each year in South Carolina. They are adapted to this area and have foliar feeding insect resistance. Scientists also are incorporating resistance to root-knot and cyst nematodes in these cultivars. These resistant varieties have two advantages: They decrease insecticide use resulting in direct savings to growers and easing environmental pollution; and increase efficiency of beneficial insect species — both predators and parasites.

The alfalfa weevil causes significant losses in alfalfa production, particularly in the Southern states where this insect pest once prevented economic development of the crop. With renewed interest in establishing large alfalfa acreages in the region, research efforts are under way to integrate crop production and pest management practices.

Analyses of root tissues show that weevil infestations deprive the crop of carbohydrates essential for long-term regrowth and sustainable yields. Agronomic practices, such as the timing of harvest dates, have similar impact, and cutting regimes in the fall were shown to compound or counteract the effects of weevil control the following spring. The data gathered through this interdisciplinary approach will provide useful guidelines for efficient alfalfa production in the South.

Mole crickets are major pests of turf and tobacco, and damage in South Carolina is increasing. Research has been initiated to determine the problem areas and the pest species present. Insecticides will be evaluated for control, and research will be conducted to study application technique and timing. Recent experiments have shown that the application of parasitic nematodes may provide control. Therefore the application of these nematodes in the form of baits will be evaluated as a biological control agent for reducing mole cricket damage.

Food Science

Efforts to enhance the development of food products and processes and to assess the effects of food processing on food nutrient availability have been central thrusts. Such efforts are typified by studies utilizing plastic films varying in oxygen permeability to enhance quality retention of shredded cabbage during storage. Plastic films with oxygen

permeability in the range of 2,300-4,000 cc/m² have the best results on a comparable basis over a nine-day test period. Of interest was the observation that the pH of the stored cabbage initially increased, but then decreased. Toward the end of the storage period it increased again, suggesting changes in respiration during the storage period.

Results suggest that the utilization of modified atmosphere packaging and refrigerated conditions will result in the maintenance of typical cabbage-like characteristics for a relatively long storage period. Additional work with plastic film of the type that upon heating, shrinks and adheres to a food product surface forming a tight skin to prevent fluids from leaving the food product, has demonstrated a marked variation among plastic films as regards the extent of binding that occurs between the packaging film sealant and the meat surface. It was demonstrated that the addition of sodium acid pyrophosphate to comminuted meat mixes significantly increased the extent of binding between the cooked meat surface and the packaging film sealants. However, the addition of sodium chloride to similar meat mixes did not effect the extent of binding of the packaging film sealants to the meat surface until a concentration of 3.0-3.5 percent was reached, which is impractical for food product applications.

Results from this study suggest that those factors that affect meat-to-meat binding and moisture retention in heat-processed comminuted meat products, such as cooked ham, also affect the adherence between the product surface and the sealant material of packaging film.

A novel application of the metallic membranes in food processing was developed by which enzymes important in numerous food processes can be immobilized on the membrane surface. This development is significant in that it permits simultaneous conversion and separation of products. The process studied involved the use of glucoamylase to convert corn starch to glucose. Glucoamylase, when immobilized on the surface of the metallic membrane, maintained excellent activity. When corn starch solutions were exposed to the membrane, the enzyme, which was immobilized on the membrane surface, hydrolyzed the starch to glucose. Simultaneously the glucose then would pass through the membrane, and the unhydrolyzed starch was recycled for subsequent conversion to glucose.

It is anticipated that this discovery can be utilized in immobilizing whole bacteria cells or cultured animal and plant cells on metallic membranes for a wide array of bioconversions. Of continuing interest is the effect of food processing operations on food nutrients. Efforts have been under way to investigate the use of a ciliate protozoan (*Tetrahymena pyriformis*) to ascertain the biological availability of food nutrients. Studies suggest that the nutritional requirements of this organism are somewhat similar to that of humans and that the growth of this protozoa can be measured by cell counting or oxygen uptake. Using these indices, a linear relationship was observed between iron concentrations in a defined media and growth over a wide range of concentrations. To investigate iron bioavailability from intact proteins, a soy isolate was utilized. But the iron content of the soy isolates was greater than the range of response that had been established for the protozoa. Thereby an adequate measure of iron bioavailability of the soy isolates was not obtained. Studies in progress with soy isolates of decreased iron content suggest that *Tetrahymena pyriformis* as an iron bioavailability assay has substantial merit.

During the past few years continued interest has developed in the effect of dietary fiber on the availability of meat proteins. Studies have been completed in which three types of meat proteins were used in combination with different types of dietary fiber. It was observed that the protein quality of some meat proteins was negatively affected by the presence of selected sources of dietary fiber. In particular, the apparent nitrogen digestability of all-meat protein diets decreased when wheat bran was exchanged for cellulose. This study suggests that the difference in cellulose fiber constituents, for example lignin, hemicellulose and cellulose, among cellulose and wheat bran may be the dietary constituents responsible for the effect observed on the protein quality of some proteins. Additional studies are under way to further examine this observation.

Home Economics

Research on the nutritional status and body composition of middle-aged, normal women continued this year to include minority women. The subjects were measured for height, weight and body fat, as well as the level of physical fitness, blood cholesterol and triglyceride. They were questioned about their eating habits, exercise patterns, health status, vitamin and mineral supplement intake and general life style. The study continues and no data have yet been recorded.

In the area of pesticides, surveys taken this year revealed that there was no cool and comfortable garment available during the hot summer months when very toxic pesticides must be applied. Research has begun to develop a suit design for protective clothing that can be worn during pesticide application, particularly air blast spraying. Researchers now are selecting fabrics that are comfortable and effectively prohibit the penetration of dangerous pesticides.

A three-year research project began this year with building researchers at Heriot-Watt University in Edinburgh, Scotland, to help consumers and industries in both South Carolina and Scotland learn to prevent and correct moisture problems in households. It is estimated that about 80 percent of the households in the state have a moisture problem of some kind because of the hot, humid climate. The first phase of the project involved collecting non-random consumer complaints of suspected household moisture that were reported to two state agencies. From the 215 complaints reported in one year, half were attributed to moisture problems. This research will provide benchmark data for Extension's work in housing education. Indepth sampling will be collected from Extension agents in the coming year.

Horticulture

Research within the Horticulture Department continues to support the needs of one the largest growing segments of the South Carolina agricultural economy. Production, handling, storage and management of fruit, vegetable, nursery and greenhouse commodities as well as the production of high quality turfgrasses requires a constant supply of practical and fundamental research support.

Fruit crops research is centered around peach production and handling. Selections from the peach breeding program continue to be tested for production and quality

attributes. Increased attention is being given to evaluations for resistance to ring nematodes and other factors associated with the peach tree shortlife syndrome. The most promising selections have been vegetatively propagated in preparation for out-planting onto a site characterized by a high incidence of the disease. One researcher is evaluating an experimental fabric for use in restricting root growth of field planted trees. Fruit yields and quality were similar to trees without restricted roots, but the amount of pruning required was markedly reduced.

Attention to postharvest quality has increased the use of the maturity prediction system developed at Clemson. This system uses a series of color chips to allow the farmer to accurately predict peach maturity by comparing peach color to the color standards. Research on other aspects of fruit production include peach rootstock selection, fertilization and nutrition, and evaluation of other fruits, including kiwifruit, for production potential in South Carolina.

Vegetable production systems are constantly being modified based upon information released by Clemson researchers. Applications of growth regulators to spinach result in easier harvest and contribute to increased shelf life of the packaged leaves. Cultural and management systems for asparagus and broccoli are being developed to increase production of these crops as alternatives. Ways to overcome transplant shock in plantings of fresh market tomatoes are being researched. New approaches are being used in variety development of vegetable crops. Two different research groups are using tissue culture to augment traditional breeding approaches. New crop ideas based upon breeding of large fruited orange tomatoes and production of seedless strains of watermelon will benefit state growers.

The ornamental and turfgrass industry in South Carolina contributes over \$278 million to the state's economy. Ornamental research includes studies of the optimization of nitrogen fertilization in container ornamental production and in golf course greens. The economics of this problem are obvious; the need to reduce nitrate contamination in ground waters is a less obvious, but perhaps more important outcome of this research. New ornamental plants continue to be evaluated for suitability to the S.C. environment in plantings at the Clemson University Botanical Garden and at the Sandhill Research and Education Center in Columbia. Geotextile fabrics may be substituted for herbicides in landscape plantings because of their unique ability to control weeds and still permit the entry of water and fertilizers. Rapid screening methods for new herbicides adaptable to use in landscape plantings may be possible with a system developed by a team of horticultural researchers. The system uses portable photosynthesis-measuring equipment to evaluate the physiological response of the various plants to herbicides. In initial trials, plants with susceptibility to herbicide damage displayed impaired photosynthesis in a fraction of the time required to evaluate the whole plant response.

Plant Pathology and Physiology

The application of a genetically altered bacterium, *Pseudomonas florescens*, to soil surrounding wheat roots was a highlight in this reporting year. Scientists at Clemson and at the Edisto Research and Education Center began a field test of this bacterium

with a \$607,000 grant from Monsanto Company. The study demonstrated that the organism did not move far from where it was placed, the numbers of the genetically altered bacteria become considerably less through the season, and the altered genes were not detectably transferred to other microorganisms in the root area. The experiment will continue to see if the altered microorganisms reproduce and become numerous around soybean roots when that crop is planted in the same field.

The next step will be to apply a similarly genetically altered organism as a biological control to see if it stays in a relatively small area. More research is expected with genetically altered organisms to see if scientists can get better biological controls, improve host plant resistance to plant disease-causing organisms, and gain a better understanding of how disease-causing organisms invade and damage plants.

Since there are no good nematicides that are effective for several of the more destructive nematodes in the state at a profitable cost, much of the research in the Plant Pathology and Physiology Department is being directed at control methods other than nematicides. One project is measuring the effect of several crop hosts on the species and race of root-knot nematode. Investigators have found at the Pee Dee Research and Education Center that both root-knot nematode species and races can be controlled by rotations to minimize losses. Growers first must determine which species or race is dominant in their fields and then match the crop and variety so that damage is minimal. Another benefit is that with the right crops, nematode species and races can be manipulated to keep the dominate nematodes that can be controlled with plant resistance. These control practices require a great deal of management and access to accurate and timely nematode identification.

Nematologists, cooperating with colleagues in agronomy and horticulture, have made significant progress in developing and executing procedures for finding host resistance to soybean-cyst and Columbia-lance nematodes. A set of recommendations has been formulated that uses resistance in such a way that a grower can manage the soybean-cyst nematode populations without severe losses. New lines soon to be developed will be even more beneficial than some varieties now used. There is measurable tolerance to Columbia-lance nematodes in soybeans, and that tolerance is being put in new lines with the expectation that new varieties will soon be available to help manage lance-nematodes populations and keep losses low.

Plant disease-causing fungi may develop resistance to certain fungicides making disease control more difficult. This has happened with the organism that causes brown rot of stone fruit. Researchers working with fruit diseases have determined that strains resistant to benomyl can be reduced in importance by using alternate sprays for as little as one growing season.

Poultry Science

Research efforts in the Poultry Science Department encompass housing, immunology, nutrition, physiology, products, management and pathology. Nutrition work concerns regulation of food intake and fat deposition in chickens, evaluation of new feed ingredients, dietary contaminants, metabolism of vitamin D, egg shell strength and nutrient requirements.

The genetics of a specific enzyme related to sugars has been identified in chickens. These inherited enzyme variations may relate to important production characteristics and allow selection for superior lines of chickens. A genetically distinct line of chickens maintained at Clemson has allowed researchers to identify specific cells that may supply a key to the secrets of the immune system. The immune system responds to special cellular products, which have been the focus of an immunophysiology study. The identification of these products and of special cell proteins will help the poultry industry protect poultry from viruses and bacteria. Birds not immune to disease agents may be protected by receiving a specific compound in the feed that attacks the disease-producing organism.

An enzyme-linked immunosorbent assay (ELISA) has been developed to detect fowl cholera antibody in naturally exposed (infected) and vaccinated turkeys. The results show that cholera exposure is much more prevalent, particularly in young turkeys (one to seven weeks of age) than once anticipated. Using recombinant DNA technology, it is possible to clone *mycoplasma gallisepticum*. Several clones that produce proteins have been isolated.

Research and Education Centers

The S.C. Agricultural Experiment Station's four research and education centers continue to stress the specialties of the areas in which they are located.

Scientists working in tobacco at the Pee Dee Center have developed 13 new breeding lines, which are being advanced and have the potential for being released for grower planting in the future. Excellent progress is being made toward breeding varieties with insect resistance with some germplasm being released.

Agricultural engineers have developed a better understanding of curing problems as they relate to air-flow in big-box curing barns. This will result in growers being able to market better quality tobacco.

Cotton investigations have resulted in developing varieties with better quality and a better understanding of the control of detrimental insects.

Corn fertility work has resulted in more efficient ways to apply fertilizer materials that will result in greater yields at reduced costs.

Vegetable research has expanded with over 400 plots that measured their adaptability and nutritional requirements. Field trials of several spices were established to determine adaptability and potential as an additional crop for tobacco growers. Agricultural engineers field tested a retrofitted tobacco harvester to be used for vegetable production.

Researchers at the Coastal Center in Charleston are producing Gervera daisies in field plantings, which could have a big impact on the expanding cut flower market. Studies at the center deal specifically with ornamentals and vegetables. The center's large urban research and demonstration area on Highway 76 South provides information to school classes, garden clubs and homeowners concerning flowers, herbs, shade trees, lawn grasses, vegetables and other plants.

Research at the Edisto Center at Blackville was highlighted this year with the historic application of the first EPA-approved field test in the United States of a genetically engineered soil microorganism. On Nov. 2, 1987, Clemson and Monsanto Company

planted wheat concurrently in rows treated with a live recombinant bacterium. The 18-month test so far has shown that genetically engineered microorganisms can effectively be tracked and monitored after they are released in the environment.

The Edisto Center also began research on interseeding of soybeans and cotton into standing wheat. This is a team effort to incorporate interseeding technology into total production systems. In addition to the actual seeding system, fuel efficiency, soil compaction, weed and insect control, and root development of the plants are being studied. This study was supported in part by a grant from the S.C. Energy Research and Development Center. Cotton research efforts, especially low input systems of production, were increased. Tissue culture techniques for watermelons and sweet potatoes were developed. Record wheat yields for the center in excess of 100 bushels per acre were recorded on some research plots.

The Sandhill Center in Pontiac focuses on fruit, nut tree and vegetable research. The S.C. Swine Evaluation Center and Livestock-Poultry Health Division are located at Sandhill.

Active Research Projects 1987-88

Agricultural Economics and Rural Sociology

An economic analysis of risk management strategies for agricultural production firms.

Economics of improving productivity in the livestock-meat systems in the South.

Labor markets and labor force differentiation in non-metropolitan areas.

Disturbances to price discovery-risk management by marketing firms in Southern agriculture.

Economic analysis of the impact of alternative flue-cured tobacco programs.

Monetary, fiscal and trade policy impacts on farm organization.

Socioeconomic dimensions of technological changes, natural resource use and agriculture structure.

Organization and operation of South Carolina water utility systems.

Growth of the South Carolina broiler industry relative to other Southeastern states and the United States.

Agricultural adjustment in the Southeast through alternative cropping systems.

Marketing strategies for agronomic crops with uncertain prices and yields.

Agricultural water use and irrigation profitability in South Carolina.

Economic analysis for coastal resources management and policy.

Consumption of and market potential for catfish and crawfish in South Carolina.

Consumer acceptance of direct marketing of fruits and vegetables.

Demographic data analyses and policy implications.

Analysis of the farmland market in South Carolina.

Rural entrepreneurship: assessment of its potential as a rural development strategy.
Analysis of structural and organizational changes in rural counties in the South.
Changing patterns of food demand and consumption behavior.
Potential for community economic development and its impact on rural residents.
Analysis of economic costs and benefits of the U.S. sugar program.
Economic and technical forces shaping the Southern dairy industry.
Competition and change in the fruit and vegetable production and marketing system.

Agricultural Education

Labor force experiences of persons trained in colleges of agriculture.

Agricultural Engineering

Agricultural meteorology and climatology for production in the Southern region.
Effect of swine lagoon effluent on hardwood seedling growth.
Processing and storage of Southern agricultural commodities.
Engineering and management systems for cotton production, harvesting and processing.
Engineering analysis and design for aquaculture of catfish, crawfish and clams.
Animal waste as nutrient and energy resources in warm, humid climates.
Automatic monitoring and controlling grain storage.
Remote sensing and sensor development for tree fruit production and harvesting.
Optimize production efficiency of animal housing systems in the Southern Region.
Electronic sorting and grading of fruit for quality and maturity.
Engineering systems for plant tissue culture.
Automatic control of field machine functions for increased efficiency and energy conservation.
Compost for control of apple collar rot.
Hydrologic/water quality modeling of sediment and chemical movement.
Drought indices calculation and testing for South Carolina soils.
Low-cost, multi-purpose vegetable production machine/system.
Modification and evaluation of a harvester prototype for small-stature high-density peach trees.
Control prediction, economics and environmental effects of soil erosion.

Agronomy and Soils

Grain yields and field performance of barley, oats, rye and wheat.

Advanced strains and cultivars of cotton, soybeans and peanuts.
Field corn and grain sorghum cultivars for grain production.
Nitrogen source for production of forages.
Development of improved soybean varieties.
Weed control in corn, cotton and soybeans.
Overcoming factors limiting biological dinitrogen fixation by leguminous plants.
Cellular and molecular genetics for crop improvement.
Chemistry of atmospheric deposition: effects on agriculture, forestry, surface waters and materials.
Life history, population dynamics and interference: a basis for understanding weed biology.
Small grain breeding and genetics.
Spatial and temporal variability of soil characteristics and material fluxes in field soils.
Rhizobia and mycorrhizae to enhance BNF in cowpeas.
Growth and nutrient uptake by soybean roots as affected by cultivars and soil properties.
Breeding cool season forage grasses.
Modifying aluminum toxicity for plants in acid soils.
Establishment and management of forage crops under stresses of environment and biotic origin.
Characterizing plant traits for improved crop performance.
Mineralogy of selected soils in the Southern region.
Environmental tracking of a LacZY-engineered natural soil bacterium.

Animal Science

Nutrition and management of swine for increased reproductive efficiency.
Estimation of pork muscle growth and evaluation of hot processing and chlorine washing for hams.
Effect of gender and feed intake on growth and serum hormones and metabolites of the bovine.
Improving reproductive efficiency of cattle and swine.
Efficacy of starter diets for early weaned pigs.
Endocrine mechanisms during pregnancy in the cow.
Physiology of pregnancy and embryo survival.
Forage components that influence nutrient digestion and metabolism in ruminants.
Genetic potential of beef cattle for forage utilization.
Genotypic evaluation of Zebu and British-Continental cattle.

Development of profitable beef-forage production systems for the Southern region.

Aquaculture, Fisheries and Wildlife

Home range and habitat use of fox squirrels in coastal plain South Carolina.

Biology of clams, whelks and other important shellfish.

Juvenile white-tailed deer dispersal and movement behavior.

Eastern bluebird home range and habitat use.

Nesting biology and gosling survival of Canada geese at Monticello Reservoir, S.C.

Effect of a statewide cooperative nest box program on wood duck production.

Lake Moultrie creel survey.

Canada goose nesting biology and gosling survival on farm ponds.

Dairy Science

Dietary factors affecting the toxic and immune response of ruminants to mycotoxins.

Optimizing nutritional management of dairy cows.

Effects of aflatoxin B-1 on bovine and avian T-cell function in vitro.

Bovine somatotropin (BST) in lactating dairy cows and concentration in dairy foods.

Use of carbon dioxide in frozen dairy-based desserts.

Effects of defined serum replacements and growth factors on cultured ovine and bovine embryos.

Entomology

Entomopathogens for use in pest management systems.

Identification and distribution of insects of potential importance in South Carolina.

Biology and control of arthropod pests on apples.

Insecticide resistance in insect pests and their predators in cotton, corn, soybeans and tobacco.

Physiological relationships between insects and biological control agents.

Biology and control of imported fire ant.

Biotypes of *Heliothis zea* in South Carolina.

Synanthropic diptera, ectoparasites and other associated pests of poultry.

Population dynamics and management of peach arthropods.

Area-wide population dynamics and ecology of the corn earworm.

Management strategies for insect pests of alfalfa.

Development biology of polyembryonic parasitoids.

Management and biology of arthropod pests of livestock.

Biology, ecology and control of selected cockroach and termite pest species.
Integrated management of cockroaches in structural and industrial environments.
Control of selected insects and mites attacking ornamental trees and shrubs.
Improved systems of control for pecan arthropod pests.
Behavioral relationships of selected pest and nonpest Lepidoptera.

Experimental Statistics

Statistical computer methodology for research planning and analysis.

Food Science

Functional properties of proteins.
An energy audit of laboratory animals using a modified whole body calorimeter.
Optimization of thermal processes for conduction-heated foods in retortable pouches.
Protein quality and dietary fiber interactions.
Processing foods by metallic membrane ultrafiltration and hyperfiltration.
Shelf-life and quality of individually shrink-wrapped fruits and vegetables.
Plasmid and genetic transfer systems in lactobacilli.
Protein and mineral bioavailability from food products.
Dietary zinc and changes in bone composition.
Trace mineral bioavailability studies in plant proteins utilizing protozoa.

Home Economics Research (cooperative with Winthrop College)

Nutritional status and body composition of normal weight, middle-age females.
Textile fiber systems for performance, protection and comfort.

Horticulture

Plant germplasm — its introduction, maintenance and evaluation.
Trickle irrigation in humid regions.
Cultural and environmental effects on strawberry.
Chilling injury of selected greenhouse plants.
Photosynthesis, carbohydrate distribution and growth in peach trees.
Alteration of stone fruit metabolism.
Nitrogen and water application practices for ornamentals and turfgrasses.
Quality maintenance and improvement of fresh market peaches and apples.
Herbicide phytotoxicity, morphology, and early disease detection in turfgrasses.
Improving plastic mulch and row cover crop systems for vegetable production.

Weed management in cucurbit crops.

Temperature effects on growth and flowering of kiwifruit.

Extending shelf life of floricultural crops by manipulation of postharvest environment.

Plant Pathology and Physiology

Forage legume viruses.

Biology and control of viruses and mycoplasmas in corn and sorghum diseases.

Biochemical and residual properties of pesticides.

Biological control of weeds with fungal plant pathogens.

Factors contributing to and control of peach tree short life in South Carolina.

Biological and chemical control for nematodes and diseases of peach and apple trees.

Causes and control of diseases of woody ornamental plants with emphasis on camellias.

Herbicide resistance and metabolism in tissue culture.

Causes and control of diseases of cereal grains with emphasis on powdery mildew of wheat.

Disease etiology and resistance in Southern pea and other vegetables.

Physiological indicators of stress in peach trees affected by peach tree short life.

Biology of genetically changing root knot and cyst nematodes of soybeans.

Distribution, ecology and pathogenicity of root knot nematode.

Control of peach tree short life in South Carolina.

Characterization of brown patch on centipede and St. Augustine grass in South Carolina.

Poultry Science

Nutritional and hormonal factors influencing structure and quality of eggshells.

Preserving turkey and chicken semen, and factors affecting semen production in turkeys.

Control of food and water intake in poultry.

Monitoring fowl cholera immunity in turkeys.

Factors affecting the ability of the hen to sequester sperm.

Improved detection and bacterin efficacy of turkey mycoplasmosis.

Development of new processes and technologies for the processing of poultry products.

Secretory cell in the genesis of the immune response.

Reproductive efficiency of turkeys.

Amylases in chickens: molecular basis and effects on growth rate.

Coastal Research and Education Center

Urban horticulture for coastal South Carolina (horticulture).

Breeding fresh market tomatoes for bareground unstaked production (horticulture).

Disease control on cucurbits and tomatoes (plant pathology).

Storage potential of selected S.C. vegetables using modified atmosphere packaging (horticulture).

Production potential of summer- and fall-harvested asparagus in coastal South Carolina (horticulture).

Nutritional conditioning, temperature and water stress at transplanting on tomato (horticulture).

Edisto Research and Education Center

Assessment of progress in breeding for soil-pest resistance in sweet potatoes (horticulture).

Breeding soybeans for resistance to insect and nematode pests (entomology).

Genetic mechanisms for soybean germplasm development (agronomy).

Breeding and evaluating sweet potatoes for food and industrial uses (horticulture).

Endemic and imported natural enemies in management of soybean insect pests (entomology).

Agronomic evaluation of quality forages in the S.C. coastal plain (agronomy).

Engineering improvement and management of forage harvesting and conditioning systems (agricultural engineering).

Breeding of watermelon and evaluation of muskmelon varieties (horticulture).

Physical and chemical characteristics of forages and their relationships to forage quality (animal science).

Propagation, hybridization and selection schemes for the improvement of sweet potato and cucurbits (horticulture).

Arthropod-induced stress on soybean: evaluation and management (entomology).

Management of *Hoplolaimus columbus* nematode on cotton and soybean (plant pathology).

Pee Dee Research and Education Center

Mycotoxins of corn and other feed grains (plant pathology).

Breeding disease and nematode-resistant, flue-cured tobacco for yield, quality and harvestability (agronomy).

Suppression of aflatoxin and nematodes in corn through cultural practices (plant pathology).

Tobacco disease and nematode control (plant pathology).

Cultural practices and variety development for flue-cured tobacco (agronomy).
 Economic management of tobacco insect pests (entomology).
 Nitrogen and phosphorus starter fertilizer rates and ratios on well fertilized soils (agronomy).
 Impact of integrated crop management practices on European corn borer and related stalk boring insects (entomology).
 Bionomics and control of insects on cotton (entomology).
 Effect of European corn borer population density on injury to corn (entomology).
 Tobacco curing models for maximizing efficiency in bulk box barns (agricultural engineering).

Sandhill Research and Education Center

Environmental and biological stresses of rootstocks in peach tree longevity (horticulture).
 Cultural and management practices of pecans (horticulture).
 Orchard groundcover management systems for peaches (horticulture).
 Rootstock and interstock effects on peach physiology (horticulture).
 Production systems for cool season vegetable crops (horticulture).
 Viruses and viral diseases of peach (plant pathology).
 Technical and economical efficiencies of producing and marketing landscape plants (horticulture).

Technical Contributions

- 2740 CLEAR AND WHITE PLASTICS FOR FREEZE PROTECTION OF ORNAMENTAL PLANTS IN SOUTH CAROLINA by Roy E. Young, J.L. Dunlap, Jr., David J. Smith and S. Andy Hale [Agricultural Engineering].
- 2741 DIGITAL CONTROLLER FOR SPEED SYNCHRONIZATION OF NURSERY CAN HANDLER by R.E. Young and J.L. Dunlap, Jr. [Agricultural Engineering].
- 2742 BODY WEIGHT PERCEPTIONS, BODY MASS INDEX, AND DIETING PRACTICES OF SOUTH CAROLINA ADULTS by M.E. Kunkel [Food Science].
- 2743 FIELD EVALUATION OF THE DRENCH TEST FOR *BLATTELLA GERMANICA* (L.) (ORTHOPTERA: BLATTELLIDAE) by Kevin S. Jordan and Patricia A. Zungoli [Entomology].
- 2744 RESPONSE OF *GLYCINE SP. CALLUS* TO SEVERAL REGENERATION MEDIA by Keese and Rupert [Agronomy and Soils].
- 2745 ROOTING OF SEMI-HARDWOOD 'HAYWARD' KIWIFRUIT CUTTINGS by J. D. Caldwell, D.C. Coston and K.H. Brock [Horticulture].
- 2746 NATURE, FORM AND MEANING — PATHWAYS TO ECOLOGICAL CONSCIOUSNESS by Mary Haque and George Taylor [Horticulture].

- 2747 LABORATORY AND FIELD SUSCEPTIBILITY OF THE ALFALFA WEEVIL, *HYPERA POSTICA* (GLYLLENHAL), TO *THURINGIENSIS* by Jonathan A. Hornby, David R. Alverson and David Parler [Entomology].
- 2748 SCANNING ELECTRON MICROSCOPY OF THE INTESTINAL WALL IN TWO SPECIES OF *TILAPIA* by Edward W. Frierson and Jeffrey W. Foltz [Aquaculture, Fisheries and Wildlife].
- 2749 PROSTAGLANDIN E2 COUNTERACTS THE EFFECTS OF PGF2-IN INDOMETHACIN TREATED CYCLING GILTS by B. A. Akinlosotu, J. R. Diel and T. Gimenez [Animal Science].
- 2750 DEVELOPMENTAL INTERACTIONS BETWEEN THE PARASITOID *MICROPLITIS DEMOLITOR* (HYMENOPTERA: BRACONIDAE) AND ITS HOST *HELIOTHIS VIRESCENS* (LEPIDOPTERA: NOCUTIDAE) by M.R. Strand, J.A. Johnson and J.D. Culin [Entomology].
- 2751 USING GREENHOUSE PLANT BEDS FOR DEMONSTRATING PLASTIC MULCH, TRICKLE IRRIGATION AND ROW COVERS FOR VEGETABLE CROPS PRODUCTION by D.R. Decoteau [Horticulture].
- 2752 IMPROVING HORTICULTURE INTERNSHIP PROGRAMS by Mary Haque and Preston Lewis [Horticulture].
- 2753 NITROSAMINE PIGMENT FORMATION AND LIGHT EFFECTS ON COLOR PROPERTIES OF SEMIDRY, FERMENTED AND NONFERMENTED SAUSAGES by Thomas W. DeMasi, Rhoda L. Dick and James C. Acton [Food Science].
- 2754 CLASSIFICATION AND PRODUCTIVITY OF SIX COSTA RICAN ANDEPTS by J. A. Martini and C. Luzuriaga [Agronomy].
- 2755 TURKEY ACROSIN I. ISOLATION, PURIFICATION AND PARTIAL CHARACTERIZATION by M. E. Richardson, A. B. Bodine, D. P. Froman and R. J. Thurston [Poultry Science].
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COOPERATIVE EXTENSION SERVICE

As the educational outreach arm of the Clemson University Division of Agriculture and Natural Resources, the Cooperative Extension Service provides information and statewide continuing education programs that can make life easier and more enjoyable for every South Carolinian. The programs cover 16 disciplines relating to agriculture and natural resources, home economics, 4-H and youth development, and community development. In addition to general education information, special programs are included for limited-resource farmers and the economically disadvantaged.

Funded by federal, state and county governments, the Extension Service was created in 1914 as a nationwide system designed to carry education from land-grant universities to the people. For 73 years, Extension has worked closely with South Carolinians helping them build a better life through dissemination of practical, useful information within its assigned areas of responsibility.

Originally conceived to help rural people, Extension responded to the changing needs of those it served by broadening its scope of activities to include urban and suburban problems.

Clemson University, through its Extension Service, maintains an office manned by agents in each county. A professional staff of Extension subject-matter specialists at the University and four Research and Education Centers around the state compiles information from research and translates it into information the people of South Carolina can use day-to-day.

From basic nutrition information to irrigation field tours, Extension staff members and volunteers are teachers carrying Clemson University educational programs to all areas of the state.

The Extension program is organized around these broad categories: agriculture and natural resources (including special programs for limited resource farmers), 4-H and youth development, home economics (including the Expanded Food and Nutrition Education Program), community development and 1890 programs conducted by South Carolina State College, in cooperation with the Clemson University Extension Service.

Recognizing that new educational programs and directions were needed to teach South Carolinians how to adjust to rapid technological, economic and social change, the Clemson Extension Service and the 1890 Extension program at S.C. State College began an intensive statewide survey in 1985 to determine what citizens of the state saw as today's most pressing problems.

Each Extension unit and county office took part in the survey, gathering information on demographics, economics, politics, technology and natural resources. Problem identification committees were formed in each county, and more than 1,000 South Carolinians listed 1,803 different concerns that needed attention.

These concerns were summarized and listed by priority. More than 5,000 people attended a series of advisory meetings around the state to review plans for solving these problems.

As a result of the statewide survey, the Clemson Extension Service and the 1890 program announced a four-year plan to tackle the concerns South Carolinians say are the most urgent. Twenty teams have been formed to design and implement programs to address each of the major areas of concern.

The teams began work in 1987. The plans of work for 1987 through 1991, put together by county and state Extension staffs and supervised by the program teams, are the result of the intensive statewide survey. To date the teams have been primarily occupied with organizing, outlining needs and designing programs.

Highlights of Extension activities within thrust teams and departments follow.

Advancing Agriculture and Natural Resources Management and Technology

Agronomic Cropping Systems Management

Forty-one agents, 19 agribusiness persons and 59 growers were trained in corn and soybeans, government programs, budget and financing, fertility, pest management and new production technologies. Training evaluations rated the sessions between excellent and very good, and 100 percent of the trainees said Extension should do more of this team educational training. The lowest rating was for length of training session, which was rated between good and very good. Each training was for one full day.

The 1987-88 program team budget was used for the development of 10 soybean fact sheets, a new weed spectrum newsletter, soybean weed response charts, sprayer calibration training equipment, a regional weed identification guide for county offices and a video camera for troubleshooting, training soil identification and other team video training needs.

A computer decision aid was developed to help agents and producers make insect management decisions. This is a state-of-the-art discussion aid program that can make a significant regional impact.

Forty agents and agribusiness personnel were trained in the first soybean diagnostic training session. This was a hands-on as well as classroom training session.

More than 140 field demonstrations were put out in 1987. Demonstrations included cultivar comparisons, fertilizer efficiency/management, herbicide comparisons, sucker controls, topping timing, plant-bed management, double-cropping alternatives, seed-size comparisons, maturity indicators, fertilizer placement, fungicide comparisons, nematocide comparisons, insect and disease surveys, inoculum comparisons, Hessian fly management, intensive crop management and growth regulator management. Approximately 30 field days were initiated to show these demonstrations to producers.

Over 110 county producer meetings were given in agronomic system management issues in 1987-88 by state specialists and county agricultural agents.

Two cotton training programs were offered in 1987-88; one on production systems and marketing and one on scouting. Approximately 15 agents and 82 producers attended the meetings.

An irrigation crop management in-service training program was presented at two state locations and funded by South Carolina Electric and Gas Co. Approximately 35 agents and producers attended these meetings.

Several key cotton counties received and were trained in the use of cotton-tex, a computerized, menu-driven delivery system for production and marketing information.

Five growers and agents were trained and participated in Gossym Comax, a computerized, interactive management system for cotton.

Aquaculture, Fisheries and Wildlife Management

The Hampton County demonstration center, which has nine ponds and 12 acres of water, has been completed. The fish have been stocked to demonstrate commercial sale procedures of channel catfish. The private sector has responded to the Clemson University initiative and is currently building ponds in the Hampton County area. The Low Country Aquaculture Corporation has been formed and will build a processing plant and 500 acres of catfish ponds. Commercial catfish ponds are currently being constructed in Florence, Richland and Hampton counties.

Additionally, approximately 100 farmers have initiated small-scale catfish production facilities all across the state. The 4-H catfish project has continued to expand with 75 youths growing catfish in over one-half the counties of the state. The use of the Fish Disease Diagnostic Lab has doubled in the last year in response to the increase in production. A catfish processing plant was opened in 1987, and catfish feed is now being produced in state. Water quality test kits have been placed in each county for training purposes, and video cassettes for training fish farmers are being developed. Training programs for over 1,200 farmers in catfish production have been completed.

The marine Extension program has continued to assist producers in shrimp, crawfish and redfish production enterprises. Numerous workshops have been conducted on marine and coastal aquaculture.

Another major Extension program addresses a new industry in South Carolina that is part of a national phenomenon of rapidly expanding commercial recreation on private lands. In 1984 South Carolina landowners leased about 5 million acres to sportsmen, generating as much as 9 million dollars. Integrated programs are being developed to optimize total economic returns from forests, wildlife and agricultural resources.

Demand for landowner assistance is overwhelming. Several workshops have been conducted for landowners and resource professionals. This program is ranked next to the top of a national list of programs to be funded through the U.S. Fish and Wildlife Service.

Dairy Management

Dairy Extension education programs during 1987-88 centered around (1) improving milk quality by reducing somatic cell counts, (2) improving dairy herd feeding programs and (3) by use of dairy herd production records.

Through the South Carolina Dairy Herd Improvement Association program, 113 herds with 14,678 cows are monitoring monthly the somatic cell count of milk produced by each individual cow. Educational programs were conducted throughout the state to assist producers with the latest technology on milking management programs to reduce somatic cell counts.

The least-cost computer feeding program was used during the year with several hundred least-cost dairy rations formulated by Extension dairy scientists and area Extension agents. Over 1,500 feed and forage samples were submitted by dairy producers, feed representatives and Extension agents to the Agriculture Service Laboratory at Clemson for chemical analysis. A field project to determine the nutritional values of feeding programs being used by the top 20 dairy herds in the state was completed. A field study to study the nutritional values at various stages of maturity of triticale was conducted on two dairy farms.

During 1987 there were 163 herds in South Carolina enrolled in the Dairy Herd Improvement (DHI) program. This included 24,597 dairy cows with an average production of 15,046 pounds of milk, 586 pounds of fat and 500 pounds of protein per cow per year. These production values showed a slight increase over 1986. There are 25 herds enrolled in the Direct Access to Records by Telephone (DART) Program. The highest herd average in the state during 1987 was 23,262 pounds of milk, 838 pounds of fat and 747 pounds of protein on 148 cows. During the 1987 DHI test year, eight herds in the state had an average over 20,000 pounds of milk. This compared to six in 1986, four in 1985, two in 1984 and none in 1983.

Extension dairy scientists worked with dairy organizations on marketing, merchandising, and promoting milk and other dairy foods. An extensive education program is being conducted with homemaker groups by Extension home economists on "Handling Milk to Assure High Quality."

A South Carolina 4-H dairy member was recognized as the National Youth Winner in the American Guernsey Cattle Club and the American Jersey Cattle Clubs Youth Achievement programs. This was the first time ever the same 4-H member has won the top Youth Award in two different National Dairy Breed Clubs.

Farm Economy

Two days of financial management training have been presented for Clemson Extension agents not working directly with the Clemson University Management Assistance Program (CUMAP) and a one-day update was presented for CUMAP agents.

Publications now being distributed are a "Financial Management Newsletter" and a "Financial Management Notebook," which accompanies video tapes. The Clemson "Financial Management Handbook" and the "Farm Record" books are now being revised. A "Small Farm Record Book" is being prepared.

The following computer programs are now available:

- FINLRB (Long-Range Financial Planning)
- MONEY MAD (Short-Term Financial Planning)
- CASHMASTER (Record Keeping Program)
- BUDGETS (Row Crop, Forage, Vegetable)

Seven financial management VHS tapes have been prepared, and efforts to put together a farm financial group paid off when the Sumter Farm Management Association was organized. This group is now in operation.

Financial management workshops were held this year in Clarendon, Lexington, Sumter and York counties, and financial management topics were incorporated into most production agriculture meetings.

Management newsletters have been started in Clarendon and York counties, and a series of news articles dealing with farm financial management has begun in many counties. In addition, a display committee is working on a small farm display targeted to management.

Forest Management Systems

Moisture is a recognized problem in South Carolina homes. The proper use and care of wood products have been grossly neglected by builders, architects and homeowners. Proper use and care are being emphasized.

Three voluntary certification programs for practitioners are being developed. Forestry faculty are working to develop one of these programs for arborists. The program is designed to improve the quality of service, competency and professionalism of arborists.

Primary and secondary industry development is a new emphasis area just getting under way through efforts to identify and promote opportunities for primary and secondary industrial development.

The overcutting of pine resources and lack of reforestation on private lands have long been recognized as major problems. Thirty-eight counties are addressing this problem. Efforts include educating the Legislature and creating awareness and stewardship among landowners. One effort involves the Master Tree Farmer program where volunteers promote reforestation among their peers. Seventy-two Master Tree Farmers have been certified. South Carolina is receiving a grant to package this program for use nationwide.

Home Food Production

Ninety-three Clemson Extension agents and 11 specialists planned 1,869 days in home food production (plant and animal). Time (days) reported by agents and specialists is 1,712. A random survey conducted in several counties provided the following estimated impact/results for FY 87-88:

- 162,000 families/individuals produced gardens.
- 51,000 families/individuals received information on home food production in one or more of these areas:

Gardening (37,766)	Swine (3,4040)
Poultry (1,472)	Fish (2,024)
Rabbits (1,518)	Other (782)
Beef (4,140)	

- 322 garden center operators and 360 Master Gardeners were trained in home food production management practices.
- 6,600 youth were involved in home food production and developed skills in these areas:

Gardening (5,060)	Swine (230)
Poultry (782)	Fish (184)
Rabbits (230)	Other (23)
Beef (92)	

- 3,700 persons marketed excess food products through farmers markets, pick-your-own operations, roadside markets, etc.
- 5,500 persons received pest management training and pesticide safety information.

Home Grounds

Major efforts were initiated by the Home Grounds Program Team to:

- Increase the number and use of Master Gardeners.
- Initiate a certification program for grounds maintenance.
- Provide needed grounds care publications to the public.
- Train agents to provide accurate home grounds recommendations.

There was an overall increase in the number of counties participating in the Master Gardener program. In the Piedmont district the number of people trained as Master Gardeners increased 70 percent. Each certified Master Gardener represents a minimum of 30 hours of volunteer time Clemson Extension receives. Master Gardeners are currently developing a state Master Gardener association with plans for an annual meeting.

The S.C. Nurserymen Association has agreed to support and administer a certification program for grounds maintenance and garden supply dealers. Similar support is expected with the International Society of Arboriculture — Southern Chapter for Arborist. Certification programs in other states have been studied.

All popular home horticulture publications have been revised and are available for distribution. This represents providing information to about 75,000 S.C. homeowners. To enhance the development of publications related to home and public grounds, a sizeable portion of the team's budget was given to the Clemson Horticulture Department to help buy a computer scanner. In addition, several video tapes have been ordered to determine their value in training Master Gardeners and stocking county VHS libraries.

Thirty-Six Clemson Extension agents received two days of training in ornamental plant identification that allows them to more effectively serve the home grounds needs in their counties.

Horticultural Crops

Three publications were developed this year which will be critical to the success of our programs.

The "Peach and Apple Spray Guide" is used by our fruit industry as a daily decision-making tool to maximize the efficiency of pesticide applications. These guides must be prepared annually to incorporate the latest chemical recommendations. The "Kiwi Fruit Production Guide" is designed to provide comprehensive cultural information to producers who are growing this alternative crop. A buyer's guide was compiled and published for the greenhouse industry and commercial sod producers.

South Carolina producers were exposed to the latest culture and management tools in shortcourses held for small fruit, vegetable, turf, woody ornamental and greenhouse growers.

Land and Water Resources

Clemson Extension agents from 42 counties were trained on the provisions of the 1985 Farm Bill. They received a handbook on the provisions of the bill and two publications on conservation planning and wetlands conversions.

Extension agents have conducted county programs in conjunction with the Soil Conservation Service on the impact of the legislation as it affected their land and water use. These programs have reached 10,000 landowners.

Clemson Extension agents in nine counties were trained to recognize and deal with problems stemming from corrosive water, efficacy of pesticides and clogging of irrigation lines. They received hands-on training and were provided the necessary equipment to solve the problems of corrosive water, high pH and acidic water. This enabled farmers in counties with the most critical problems in these areas to get solutions from their local Extension agents.

Livestock Management Systems

One day of in-service training that pertained to production practices was held in each Extension district in addition to one day per district training on youth livestock events and programs. The production training was designed to review management practices that would improve reproductive efficiency, forage production, herd health practices and nutritional standards. The need for improved livestock handling facilities and the effectiveness of an adopted livestock management system was emphasized, thus elevating livestock to a business with higher priorities than has traditionally existed.

The youth portion of the training emphasized youth livestock projects, shows, camps, trail rides and judging events designed to encourage additional participation.

The livestock/forage field days have been the most successful series of field day programs ever. Educational programs were held at the Clemson University animal science farm at Clemson in May, at the Pee Dee Research and Education Center at Florence in September, at Edisto Research and Education Center at Blackville in December and at Bob Jones University Farm near Greenville in April. Each program was well planned and well attended.

Cow-calf educational clinics were held in Anderson, Chester, Darlington, Laurens and Orangeburg counties. Attendance ranged from 60 in Darlington to 250 in Anderson. These events are very popular because live cattle can be used for demonstration purposes.

The first judging clinic was held at Clemson in May. Agents and adult leaders were invited. This first attempt was well received, and there should be increased interest in the second clinic scheduled in the winter of 1989.

The youth livestock programs took some new twists in 1987-88 with the implementation of the Junior Beef Round-up. Nearly 100 youths showed 168 heifers. Krista Felder of Orangeburg was a national 4-H winner in the horse project. The training of volunteer leaders for 4-H livestock clubs has a high priority, and progress was made through several days of in-service training and through the Horse Leader Symposium, a judging clinic for all species.

A survey that will provide data on livestock herd health, reproduction, nutrition and breeding programs is ready to mail to owners of horses, cattle and swine in South Carolina. Such data will provide information on change and will help us develop yearly educational programs and long-term goals.

Marketing, Packaging and Utilization

The objectives of this program include providing agricultural economics-related educational programs and training to farmers, Extension agents, agribusinesses and consumers about agricultural marketing, policy and international trade.

Highlights for 1987-88 were:

- 280 cotton producers improved their quality practices, resulting in \$150,000 increased income from higher cotton quality. Some 350 tobacco producers improved quality practices, resulting in \$250,000 increased income.
- 250 farmers and agricultural leaders were taught the key linkages between trade and agriculture, providing better understanding of marketing and demand for agricultural products.
- More than half of the state's 260 dairy farmers were informed about the impact of a federal milk marketing order on their operations. This provided dairymen policy alternatives for dealing with milk marketing problems.
- 2,000 farmers, lenders and agribusinesses used computerized spreadsheet analysis to evaluate preferred participation in 1988 farm programs. In many instances net farm income was increased by making the appropriate farm program choice based on computerized analysis.
- 500 farmers gained a better understanding of marketing alternatives and the need for a marketing plan. Net farm income prospects have been enhanced on these farms through the use of commodity options as a forward pricing alternative.

Expansion of the food processing industry is vital for the economic growth of the state. In 1987 a South Carolina food processing company decided to expand manufacturing capabilities by installing a processed cheese manufacturing facility. This was a new venture since the company previously contracted with a Wisconsin company to manufacture its processed cheese. This plant then became only the second in the Southeast to produce processed cheese. Clemson food science personnel provided technical assistance in plant design and layout, sanitation and good manufacturing practices that enabled the new facility to begin manufacturing processed cheese in May 1988. Through these efforts, South Carolina gained an investment valued at \$500,000 and the creation of approximately 40 new jobs.

Listeria is a food-borne disease of major concern to the dairy industry. In previous outbreaks of this disease, the fatality rate has been as high as 30 percent. Since the listeria bacteria is readily found on the farm, raw (unpasteurized) milk naturally contains it. As a consequence, milk processors must use proper sanitation and pasteurization techniques to prevent the contamination of milk with this dangerous bacteria.

Clemson Extension food scientists published the first Extension bulletin in the United States written specifically for the milk plant operators. The bulletin describes the listeria problem and summarizes steps that should be used to prevent contamination of pasteurized milk and other dairy products with listeria. This bulletin has received recognition throughout the United States, and more than 1,000 copies have been requested. Recently, APC-Glacier, Houston, Tex., used the bulletin as part of a short course for milk plant operators on ways to prevent the contamination of ice cream with listeria. In addition, Diversey-Wyandotte, Wyandotte, Mich., has distributed copies of the bulletin worldwide.

A training program of New Horizons, a sheltered employment and adult developmental mental center located in Rock Hill sponsored by the Mental Retardation and Developmental Disabilities Board, focuses on teaching skills used in the baking industry for the manufacture of oven-baked cookies, cakes, breads and rolls. Basic baking equipment was installed in a converted classroom. After a request from New Horizons, Clemson Extension food scientists provided recommendations on upgrading the teaching facility to commercial bakery status to permit New Horizons to market their baked goods when volume exceeded program feeding needs. More importantly, the placement of mentally retarded students trained in the baking industry would be easier if they were trained in a facility comparable to a commercial operation.

Clemson Extension food scientists, in collaboration with regulatory agencies, began working with New Horizons on the necessary upgrades and product labeling for the facility to be operated as a commercial bakery. The modifications took about three months. Since completion, 10 mentally retarded adults have entered New Horizons training with hope of becoming functionally self-sufficient through future employment in the baking industry.

The catch of South Carolina shrimp trawlers contains a mix of fish, shellfish and shrimp. Of the shellfish portion, conch is one species frequently thrown back. In Europe and Asia, conch meat is a delicacy, and it's also popular among several ethnic groups in the United States.

A South Carolina seafood processor was provided technical assistance to establish a canning facility for conch. In 1982 an EOC non-profit/self-help community cannery was constructed at Penn Center on St. Helena Island in Jasper County on recommendations of Clemson Extension food scientists. The facility was upgraded, and leasing arrangements (approved by regulatory officials) were completed. Clemson food science personnel assisted with equipment procurement and installation as well as making arrangements for cannery personnel to get required certification. The heat penetration determinations and processing calculations to establish schedules were done by Clemson Extension food scientists.

Four months later the first can of conch meat was processed, labeled and ready for market. This facility created 12 new jobs. Immediate benefits to the state included

establishment of a new and viable business venture, direct economic support to a minority educational program (Penn Center), creation of new job opportunities, marketing a new food product from the state, and giving value to an agricultural resource that was already being caught, but discarded.

Poultry Management Systems

Formation of the South Carolina Poultry Federation has unified the 7,700 people directly employed by the poultry industry in the state. Poultry commodity groups are now working toward a common goal of promoting the economic development of the \$440 million poultry industry in South Carolina. The federation is working to promote the industry by providing educational programs for industry personnel, educating the public on the value of the industry, and by providing a unified political voice.

As a part of the educational program, the second annual poultry housing and ventilation seminar was jointly sponsored by the S.C. Poultry Federation and Clemson's Poultry Science Department. More than 100 industry personnel from 11 states attended to study methods to reduce losses during hot weather.

In an effort to reduce losses in the hatchery and processing plant, quality control programs were developed for two major hatcheries in South Carolina. The result was a significant improvement in hatch followed by a reduction in processing plant condemnations.

In response to continued environmental concerns, the publication "Disposal of Dead Poultry and Livestock" was developed to provide producers with guidelines for properly handling the disposal of dead poultry. This publication has been adopted by other state agencies as an educational tool to help livestock producers plan proper disposal facilities.

Strengthening The Family

Family Life Education

Parenting was selected as the major focus in family life education. Materials were developed for parents of children up to four years of age. The program, Parenting Renewal, aims at helping parents in the following components: guiding development, facilitating a healthy self-concept, developing good food habits, guiding children in achieving self-discipline, keeping children healthy and safe, coping with parenting, communicating with children, and seeking help and support. Thirty-seven county home economists were trained.

A day-long workshop in parenting renewal held in Richland County exemplifies expected program outcomes. The workshop was attended by 70 individuals ranging from incarcerated mothers to high school home economics students and stay-at-home mothers. Resource persons and packets of literature enriched the program. Additionally, family court judges, state agencies personnel and commissioners, and professional associations have been advised of the availability of the program and the trained agents. The South Carolina Commission on Women has announced the curriculum in a publication distributed statewide.

Other areas in which South Carolinians received assistance through Extension efforts include parent-teen relationship, child and adult day care, and stress management.

An interactive video on parent-teen relationships was designed for use in shopping malls and places where exhibits are appropriate. The objectives of this program are to help parents and teens learn to understand each other better, improve their listening skills and to foster conflict resolutions.

The Children and Adult Resource Express (CARE) is an information and referral system for children under 17 and for adults over 55. The system contains information about service providers by county, a list of day care facilities for children and for adults by type and by county, a listing of living arrangements for the elderly by type and by county, legislative information and demographics. This program is being partially funded by a grant from the Health and Human Services Finance Commission and was developed over a two-year period.

Family Resource Management

Human capital development has been recognized as a vital need by Extension staff, community leaders and lay people for the revitalization of rural America. Programs have been designed and developed and agent training conducted in financial management, establishing home-based businesses and the job search process to reach such target groups as unemployed farm families, young families, mid-life men and women, and those approaching retirement.

Financial management information reached over 1.5 million individuals through media contacts including radio, newspaper, newsletter and farm publications. Buying power increased by \$236,000 as 25,700 individuals/families employed financial management skills and utilized wise shopping and credit practices.

Through interagency cooperation with the American Association of Retired Persons (AARP), two programs, Women's Financial Information and WORKS, targeted to midlife and older women will be piloted in rural South Carolina during 1988-89. South Carolina is one of five states in the United States to be asked to participate in the WORKS program, which deals with improving job search skills. Additionally, South Carolina was one of 11 states selected to implement a financial management program for youth and young adults developed by the College for Financial Planning. Nine locations in the state piloted the program in the spring of 1988. In the future these three programs will become available to all Extension clientele in the state.

The File It, Find It program developed by the family resource management team is designed to provide adults and youth the tools needed for efficient handling of personal papers and business transactions in order to save time, money and energy.

In March 1988 Extension agents in the counties were trained to present this program. Since the training, 16 counties have conducted programs, and more than 2,000 copies of each of the four publications developed to accompany the program have been distributed by 26 counties. Additionally, the program was presented at a national conference, and people from 31 states, the District of Columbia and Canada have requested copies of the publications.

Monthly newsletters, articles in local newspapers, in-service training for teachers and home study courses represent the variety of formats used by Clemson Extension agents

in presenting the program. One county sent out 60 copies each of the four publications in response to requests generated by a mall exhibit. A leader training program in another county resulted in 120 adults receiving the materials.

In one county the agricultural and home economics agents are working together to provide the program in a workshop format. Other agents are presenting programs in cooperation with businesses and technical colleges as well as working with clients on a one-on-one basis. Programs are being held in churches, the county office and at local technical colleges. In addition to working with adults, several counties have presented programs to youth groups.

A major effort has been expended in support of the textile industry in South Carolina. Much of this effort has been directed through, and shared with, the South Carolina Extension Homemakers Council. The SCEHC Cultural Arts, Clothing, Textiles and International Committee sponsored the "Made in the USA" program, which incorporated county fashion shows of garments made of fabric produced in the USA.

The Cornell University intercept research survey on domestic versus imported apparel was duplicated in two locations in South Carolina in cooperation with the S.C. Extension Homemakers Council. The homemakers interviewed 500 individuals in this study to compare results of the survey in a textile dependent area with those of a non-textile dependent area. These projects resulted in a national award for the South Carolina Extension Homemakers Council.

An apparel design project, co-sponsored by the psychology and nursing departments, has been developed to ascertain attitudes of women toward certain aspects of gynecological examinations. The social and psychological aspects of clothing as it relates to job interviews and job performance supported the Finding Work and 4-H Life Skills in-service training, as well as agent orientation and a number of programs presented for counties and groups of individuals.

Housing

With housing costs at record highs, Extension educational programs in housing assist South Carolina families in using alternatives to traditional housing and in maintaining homes. Families in nine South Carolina counties received information to help modify their homes to meet needs of handicapped, elderly or ill family members. Others received help/consultation on selecting or modifying a house plan for a new or existing home.

South Carolina citizens (approximately 325 in a sample of six counties) attended public meetings on planning new and remodeled housing. Topics explored were preventing home moisture problems (including landscaping), budgeting for housing, financing a new home or remodeling an old one, and closing costs when buying or remodeling a home. More than 2,000 persons used the Extension housing study guide in touring the Columbia Parade of Homes. Through Extension mass media coverage, South Carolinians are increasingly aware of potential home moisture problems and economic consequences.

Two new publications/checklists can help identify, prevent and correct moisture problems in their homes: "Landscape Management Checklist: Preventing Home Moisture Damage" and "Home Management Checklist: Preventing Home Moisture Damage."

The state is served by 225 professional pest control operators (PCO) who are more knowledgeable on identifying, preventing and correcting home moisture problems as a result of training sessions in 1987-88. In one reported case, a homeowner was able to avoid the costs of severe structural damage because a trained PCO spotted *poria incrassata* growth at an early stage.

Developing Human Resources

Health and Wellness

Over 13,000 youth participated in a 4-H Fire Safety Education program that helped youth identify potential hazards in their home and community.

Development continues for the broad-based local Teen Pregnancy Prevention Councils. Currently, all except four counties have active councils. Extension participates in all of these councils and has major leadership roles in at least half of them. The councils are functioning under the auspices of the State Maternal, Infant and Child Health Council out of the Governor's Office.

The "Baby Talk" series has proven to be of great benefit to young, lower income mothers. Negotiations are under way with the State Health and Human Services Finance Commission to fund the printing of "Baby Talk" for Medicaid mothers, many of whom fall into the young, lower income category.

The agromedicine stress project is a part of a joint effort by the Medical College of Charleston, S.C. State College, Winthrop College and Clemson University. Students from each institution work together on rural problems. The Clemson component focuses on how Southern families cope with stress and how stress is affected by nutrition. The study utilizes farm and EFNEP families in Orangeburg and Beaufort counties. Results of this study will be used to plan and conduct additional educational programs to help South Carolina families cope with stress.

Human Nutrition

The human nutrition team is concentrating its efforts in two program thrusts. The first is helping consumers make wise food and nutrition decisions, which will result in improved health and well-being. Second, because it is anticipated that Extension will receive over 100,000 calls in the next four years on food safety, the program team will emphasize the safe handling of food.

Examples of significant work under the first thrust, helping consumers make wise food and nutrition decisions, are: a new food guide has been developed with the South Carolina Department of Health and Environmental Control, Office of Nutrition. This guide will be used by both agencies with over 50,000 South Carolina consumers.

About 45 programs were presented in counties on the relationship between nutrition and chronic disease, such as calcium and osteoporosis, nutrition and heart disease. Twenty-eight counties presented Extension's weight control program, Diet Puzzle, reaching approximately 350 overweight persons with accurate and up-to-date information.

The second major effort is the safe handling of food in the area of food conservation and safety this year. The Clemson University Forestry and Agricultural Computer

Network was used to disseminate the latest information from USDA on the home food canning. This network has been used extensively this summer in assisting consumers with safe food preservation methods.

A \$20,000 grant was received from the S.C. Department of Health and Environmental Control for an educational program on the relationship between coronary vascular disease and nutrition. A part-time county Extension agent was employed in Florence to conduct educational programs and demonstrations on the prevention of cardiovascular disease through improved diet and food preparation methods. As part of the grant, a seven-lesson home study course on the Dietary Guidelines for Americans has been developed. This course was pilot tested in Florence with 100 families in July and August 1988.

A regional teleconference on Women and Health: Risk for Chronic Disease was presented at 11 sites in South Carolina in January 1988. The South Carolina Nutrition Council financed this program, with Extension supporting and publicizing it.

Fifty-five Extension agents with foods and nutrition responsibilities received a five-day in-service training in Human Nutrition and Advanced Food Conservation. Materials on stress, nutrition and health have been distributed to agents in all 46 counties.

The Expanded Food and Nutrition Education Program (EFNEP) is a federally funded program administered by the Clemson Extension Service. Its primary purpose is to improve the diets of low-income families, thereby enabling them to enjoy better health, improved stamina and increased productivity. About 16 percent of the state's population (303,233) has incomes below the poverty guidelines.

During 1987-88 approximately 4,200 limited-resource homemakers were reached through the EFNEP's adult phase in 40 counties in the state. About 40 percent of these homemakers graduated in 12 months or less by reaching a designated level of proficiency in relation to food and nutrition knowledge and practices. Ninety percent of enrolled homemakers showed improvement in their diet and food handling practices.

Approximately 7,500 youth were involved in the EFNEP Program last year. They learned wise food choices, how to prepare nutritious snacks and simple meals, and how to handle food safely. Most of them participated in community groups led by volunteer leaders. One thousand leaders contributed approximately 10,000 hours to the program. About half of these youth (3,500) also participated in regular 4-H activities or stayed in 4-H after graduating from the EFNEP Program.

EFNEP homemakers were informed of services of other agencies, especially those related to health and nutrition. There has been a 100 percent increase in the number of referrals to EFNEP from other agencies in the past two years.

Leadership

The Leadership Program Team developed three objectives to be accomplished over the four-year plan of work:

- Develop a statewide leadership consortium.
- Develop a leadership training system.
- Develop a volunteer leadership management model.

Major efforts this past year have been in the second objective.

A three-day in-service training program was held in January for county Extension agents and volunteers entitled Leadership Skills for Extension: Focus on Advisory Councils and Committees. This training was partially funded by special grant money and was attended by approximately 130 agents and 15 volunteers. The inclusion of volunteers is part of a major effort by the Leadership Program Team to promote and implement the idea of shared leadership in Extension. A major emphasis of the training was the study of the LOOP model of working with volunteer leaders. LOOP stands for Locating, Orienting, Operating and Perpetuating volunteer leadership.

From evaluations, discussions and informal comments, it is believed that those attending:

- Have a better understanding of staff and volunteer roles in advisory committees.
- Have a good understanding of and will use the LOOP model of working with advisory committees.
- Will begin the practice of the methods studied with advisory boards upon their return home.

The enthusiasm generated at the meetings indicates the ground work is in place to move forward with the four-year leadership thrust.

A special in-service training, Catch the Vision of Extension Volunteer Leadership Tour, was held in May for about 55 agents and volunteers. Four different tours to four separate regions of the eastern United States examined use of volunteers within all Extension programs. States visited included Indiana, Kentucky, North Carolina and Virginia. As a result of these training tours, participants will be expected to:

- Develop a greater appreciation for expanded programming through the use of volunteers.
- Better utilize techniques for volunteer involvement within all Extension programs.

Enthusiasm is high among agents and the participating volunteers in this past year's programs. Plans for the coming year include follow-up trainings to the past year's trainings and an intensified in-service training on leadership training modules using the Family Community Leadership (FCL) program. This training and the materials will be partially funded by a grant from the W. K. Kellogg Foundation through the South Carolina Extension Homemakers Council.

The result of this and subsequent programs will provide teams of volunteers and professionals in all counties to teach leadership skills through the concept of "shared leadership."

The Extension Homemakers Council represents a major volunteer leadership effort. South Carolina's growing population increases the potential audiences needing Extension home economics information. Cuts in appropriations and resulting reductions in county staff have emphasized the need for volunteer leadership development to continue and expand the impact of the Extension Homemakers organization and other Extension volunteers.

The South Carolina Extension Homemakers Council has active councils in all 46 counties with more than 6,600 member volunteers. The value of Extension Homemakers volunteer time is estimated to be more than \$1,000,000 annually reaching thousands of clientele, multiplying the efforts of Extension to disseminate educational information.

More than a year ago a \$3,000 grant was received from the Kellogg Foundation to develop a leadership/public policy program called Family Community Leadership (FCL). Four county teams of six members each were trained in the pilot program. These teams have reached an estimated 600 people with leadership training. An additional \$50,000 grant has been received from Kellogg to expand the program to all counties. The program emphasizes the concept of shared leadership and the cooperation of volunteers and professionals to accomplish the program end result.

Youth Development

The development of the life skills framework for focusing, directing and planning in all Extension youth programming was the major accomplishment. It has been exhibited in programs at county, area and state levels. It also has appeared in news reports, volunteer trainings, youth speeches, camp programs, etc. It is providing Extension an opportunity for consensus in its 4-H and youth development effort. Training has been provided for paid and volunteer staff. Materials are being developed to assist all staff in more complete incorporation.

The 4-H and Youth Development Program is the educational component of the South Carolina Cooperative Extension Service for youth ages 9-19. The program is community based with family and volunteer support.

Adults and youth working together on topics of personal concern and community betterment is the basic 4-H method of education. The uniqueness of 4-H is the direct relationship to the land-grant system and the emphasis on applied and experiential learning experiences. Assisting youth with current issues and helping them explore career options is a major goal of 4-H. Special emphasis was placed on teen pregnancy and substance abuse prevention in 1987.

4-H began with preparing youth for the current and emerging agricultural and family needs of the early 1900s. It has continued to mature with the changing times and needs of youth and families. Learning activities for developing the following life skills are reflected in curriculum delivered:

- Business Management
- Relationships
- Decision making
- Leadership and Knowledge Transfer
- Communications
- Careers and Jobs
- Understanding and Accepting Oneself

The program also provides opportunities and encourages youth to become actively involved in their community decision-making process.

Nearly 58,000 youth participated in South Carolina in 1987. Major curriculum areas and participation is as follows:

15,296 Natural Resources	6,121 4-H Camping
5,864 Plant & Sciences	5,967 Outdoor Education
10,451 Mechanical Sciences	13,524 Health & Safety
2,465 Communication Arts & Sciences	11,226 Animal & Poultry Sciences
3,503 Leisure & Cultural Education	
28,069 Individual & Family Resource Management	
2,547 Citizenship & Community Development	

Sixty five percent (37,718) of those participating live on farms or in rural areas with 27 percent (15,413) from cities of 10-50,000 or greater. Fifty-two percent (30,246) are black and 47 percent (27,198) are white. Forty-eight percent are female and 52 percent are male with 68 percent 12 years of age and under. More than 5,000 of the participants are 16-19 years of age.

Every 4-H unit is a branch classroom of Clemson University, every participant is touched by knowledge from Clemson University, and every 4-H leader is a volunteer staff member of Clemson University.

Developing Communities

Rural and Community Resources

The Rural Resources and Community Development Team conducted a community development seminar in Greenwood, updated a video and memo on leadership and problem identification for counties, coordinated public policy training in 34 counties, published a series of leaflets entitled "Finding Work," and provided training to accompany this subject matter series.

Team members traveled to Alabama in March to gather ideas for information to help program planning on wildlife resources for recreational, economic and ethical benefit of the area. Two team members attended the National Revitalization Rural American Initiative Conference in Arizona, and the Rural Resources Team chairman participated in a regional economic development workshop in Greenwood.

During the remainder of the year the team plans on implementing community development committees, solid waste and land use concerns, a training program on both growth and declining counties, and a policy training update.

Publications are planned on community improvement and beautification, litter control, 4-H enrichment, and land use and zoning.

The team is considering staging a state rural revitalization conference this winter.

DIVISION OF REGULATORY AND PUBLIC SERVICE PROGRAMS

The Division of Regulatory and Public Service Programs is one of five administrative divisions within the College of Agricultural Sciences. The division was established in 1970 and consists of the director's office and four departments: Fertilizer and Pesticide Control, Plant Industry, Seed Certification and a portion of Agricultural Chemical Services. The mission of the division is to ensure compliance by the regulated industries and individuals with the legislative mandates and regulations promulgated thereunder. It also provides assistance and services to those affected to educate and to help them achieve compliance.

Division programs promote the use of certified seeds and plants; provide the services needed for certification of crops and plants; assure that fertilizers, lime, pesticides and

seeds meet the standards to produce marketable, safe and profitable crops; provide inspections to monitor pesticide treatments by the pest control industry; and provide inspection to assist the state's plant industry in maintaining plant material and agricultural commodities apparently pest free.

The following activities highlight the division's work for 1987-88.

Agricultural Chemical Services

This department performs the chemical analyses reported by the Department of Fertilizer and Pesticide Control. Most samples analyzed were multi-component, with more than 24,000 individual analyses made. The laboratory has concentrated on improved methodology, instrumentation and organization to analyze all samples quickly and accurately. The department performed more than 62,300 analyses for the S.C. Agricultural Experiment Station. In addition, the Agricultural Service Laboratory processed more than 78,000 soil samples, 5,000 plant and feed samples and 5,100 samples for nematodes.

Plant Industry

Activities within the department for 1987-88 fall into 14 subject areas, reported as follows:

Nursery Inspections: Under provisions of the Crop Pest Act, 596 nurseries, greenhouses and vegetable transplant growers and 981 nursery dealers, including nine dealers outside the state, were licensed to sell plant material. An additional 217 establishments were visited on routine inspections to determine compliance with quarantines and regulations to provide assistance with pest problems. Forty-one other nurseries were not certified on the initial inspection due to pests, weeds or other problems.

Phytosanitary Certification: A total of 309 phytosanitary certificates (182 state and 127 federal) were issued for various agricultural planting seed, plant material and other commodities. The plant material consisted mainly of chrysanthemum cuttings and orchids destined to other states, Puerto Rico, Canada and 43 other foreign countries. Fifty-nine phytosanitary certificates were issued for shipments of plant material to Canada. The majority of the other foreign shipments were to Saudi Arabia, Spain, Japan and Great Britain.

Miscellaneous Inspections: Thirteen regular certificates of plant inspection were issued for assorted houseplants being moved within the United States. Inspections of tobacco plant beds were again made for Pee Dee area growers in connection with North Carolina's import permit requirements. Approximately 40 import applications were received from the N.C. Department of Agriculture this year for growers seeking S.C. plants.

Post-Entry Inspections: Five post-entry inspections were conducted. Plant material involved feijoa plants from New Zealand, apple seedlings from France and eucalyptus plants from Brazil.

Sweet Potato Inspections: Forty-six inspections were conducted for approximately 20 growers in the Pee Dee, Sandhill and Coastal Plains regions.

Phony Peach: The 1987 survey for phony peach disease was conducted in the Ridge, Sandhill and Coastal Plains areas. Four temporary inspectors were hired. About 1.3 million trees were surveyed with 478 (0.04 percent) found diseased.

Bee Disease Act: The Varroa mite, a new pest of the honey bee, was detected and confirmed in two South Carolina counties (Greenville and Horry) during 1988. Both finds involved migratory beekeepers from Maine and New York who were overwintering bees in the state. A statewide survey of commercial and hobby beekeepers was initiated in April 1988. Apiaries in 13 different counties with 4,749 colonies of bees were surveyed. Nine percent of these colonies were sampled for the Varroa mite using the Apistan strip method. The positive finds consisted of 223 colonies that were treated and moved out-of-state for crop pollination purposes. Approximately 2,000 colonies were checked using the ether roll detection method during the fall and were also negative. A total of 1,850 empty supers (bee hive fixture) were certified for movement to other states. Additionally, the majority of the bees surveyed belonged to migratory beekeepers who moved them back north during the spring.

Cooperative State/Federal Programs: The department and USDA renewed a cooperative agreement in 1987 which provides that the state hire seasonal employees. About 72 persons were hired to survey and perform control activities associated with the gypsy moth, witchweed and bee programs.

Witchweed: Statistics for 1987 show that seven new farms with a total of 191 acres were infested with witchweed. Approximately 4,280 actual and 8,560 aggregate acres were treated. A total of 2,291 farms and 61,698 acres have been released from quarantine since program inception. Five counties representing only 17,967 acres remain under quarantine in South Carolina.

Gypsy Moth: In 1987, 642 adult male moths were trapped as compared to 497 in 1986. Again, the majority (570) were trapped in Horry County. Moths were trapped in 11 counties, setting new state records in Hampton and Oconee. Approximately six acres at Surfside Beach received two ground applications of *Bacillus thuringiensis*. A third treatment was made to the infested properties where egg masses were found.

Boll Weevil: The 1987 eradication program was very successful, but boll weevils were still evident in certain areas. Considerable migration from Georgia occurred in the buffer zone with some spilling over into 500-600 acres of the eradication area. However, the eradication program expanded into Georgia, Alabama and Florida during the fall of 1987. Diapause treatments on the entire acreage in these states will benefit South Carolina tremendously in 1988. Thus far in 1988, 150 acres have been treated in Lee and Berkeley counties. Approximately 15 percent of the acreage (8,000 acres) in the old buffer zone has received two pinhead square treatments in 1988. The boll weevil count has declined since these treatments.

Imported Fire Ant: This pest continues to spread throughout the state. The majority of our efforts were concentrated on working with nurseries, turf growers and other individuals to certify plant material for shipment to non-infested states. Department personnel supervised specific regulatory treatments for this purpose.

Exotic Pest Detection: A total of 180 traps were placed in 90 different cotton fields located throughout nine counties. The target pests were two exotic cotton leafworms and the false codling moth. A number of other specimens were collected, but none of the targeted pests.

Japanese Beetle: The remaining area of Lee County was trapped. Trap results indicated the entire county is generally infested.

Seed Certification

Seed certification is a program of standards imposed on seed and plant production that ensures varietal purity, good germination and freedom from noxious weed seeds. Participation in the program is voluntary.

Clemson University was designated by law in 1945 as the agency for inaugurating and carrying out a program of certification of pure seed and plants in South Carolina. The Seed Certification Department at Clemson and other seed certification agencies in the United States must comply with standards for certification of seed in Federal Seed Act Regulations.

Departmental field work in 1987-88 involved inspections of 27,808 acres of crops for certified seed production. Inspections included 68 varieties of 15 crops for 146 farmer/growers and 13 seed-producing firms. Each field was inspected to determine that the crop was true to variety and free of noxious weeds and seed-borne diseases.

Major acreages of crops inspected were soybeans, 14,427; small grains, 11,012; cotton, 1,234; peanuts, 519; turf grasses, 270; and pine trees, 263. Other field work involved grow-out plantings of 222 samples of South Carolina certified soybean and small grains seed for comparison to the producers' or seed conditioners' samples of the same lots.

During 1987-88, 551,547 certified seed tags were issued to growers whose seed met standards both in the field and in the laboratory. Twenty-seven facilities were inspected and approved during the year for custom conditioning of South Carolina certified seed.

Fertilizer and Pesticide Control

The Department of Fertilizer and Pesticide Control is responsible for education and enforcement of the provisions of a number of laws and regulations. The South Carolina Fertilizer Law and the Liming Materials Act are primarily designed to ensure that consumers receive high quality fertilizer and lime, while the Pesticide Act regulates storage, sale, use and numerous other areas as well as quality control. Some of the major activities of this department relative to fertilizer and lime from July 1, 1987, to June 30, 1988 follow:

Fertilizer tons sold	459,989
Fertilizer samples procured and analyzed.....	4,376
Fertilizer samples not meeting guarantee	737
Lime material and samples procured and analyzed	229
Total of liming material samples not meeting guarantee	15
Percent of liming material samples deficient	6.6
Fertilizer penalties collected, payable to State Treasurer**	
(Deficiencies where consumers not identifiable)	24,169

Lime penalties collected, payable to State Treasurer** (Deficiencies where consumers not identifiable)	1,520
Fertilizer registration fees collected, payable to State Treasurer**	4,871
Lime registration fees collected, payable to State Treasurer**	800
Lime permit fees collected, payable to State Treasurer*	1,850
Fertilizer taxes turned over to State Treasurer**	16,652

** Actually recorded by State Treasurer July 1, 1987-June 30, 1988, but may not correspond to final fees paid for the fiscal year.

The fertilizer tonnage sold this year was down slightly from 1986-87. Overall 17 percent of fertilizer samples did not meet the guarantees within the investigational allowances. This deficiency rate was the same as in 1986-87. Other than deficiencies, the greatest problem in the fertilizer and lime areas continues to be the lack of proper labeling of bulk material.

The South Carolina Pesticide Control Act mandates quality control monitoring and regulates the sale, use and application of all pesticides used in South Carolina. This department uses a strong preventive education program coupled with fair enforcement actions when necessary to help ensure productivity while preventing adverse effects on man or the environment.

In an effort to improve its education and enforcement capabilities, this department has pursued external funding sources where possible without decreasing the flexibility of the pesticide program. These efforts have resulted in two grants totaling \$164,756 from the EPA. The department has also made a concerted effort to increase efficiency by using state-of-the-art data management. All fees collected under this act are sent to the state treasurer.

In 1987, 771 companies registered 7,928 pesticide products for sale in South Carolina. A total of 956 pesticide samples were collected and analyzed. Five were found deficient in the guaranteed percentage of one or more ingredients. Stop-sale notices were issued on all deficient products. Registration fees totaling \$135,307 were deposited.

Using provisions of the Federal Pesticide Control Act, the department issued three Section 24 (C) special local need registrations. Two section 18 emergency exemptions were solicited and were granted by EPA.

Pesticide dealers and applicators must be certified and licensed to buy, sell or apply pesticides that are classified for restricted use. Last year, 9,785 private applicators licenses, 1,911 commercial applicators licenses, 871 noncommercial licenses and 389 pesticide dealers licenses were issued. Certification fees totaling \$66,075 were collected.

In the area of education and enforcement, the department's specialists made frequent contact with pesticide users, including dealers, growers, applicators and consumers. The structural pest control area, as always, requires particular attention. Chlordane and heptachlor were removed from the marketplace. Dealer inspections and meetings with pest control operators were necessary to assist this transition. The Chemigation Act increased regulatory efforts to protect groundwater, and much effort was directed into this area.

Enforcement actions against violators were again decisive but fair this year. As part of the EPA/DFPC Cooperative Enforcement Grant, 319 marketplace inspections, 182 certified applicator record checks and 245 restricted use pesticide dealer inspections were made.

Sixty-three civil penalties ranging from \$50 to \$1,000 and totaling \$11,300 were assessed, and four criminal prosecutions resulted in convictions. Four license suspensions were issued. A total of 140 investigations were conducted on potential pesticide misuse or noncompliance with regulations. Numerous stop-sale notices were issued for unregistered products, sale of restricted products by unlicensed dealers and other violations. Warning letters were issued in 122 instances. Overall compliance with the act by members of the agribusiness industry has been excellent.

Administration of the department's regulatory programs resulted in \$362,544 being sent to the state treasurer.

LIVESTOCK-POULTRY HEALTH DIVISION

The Livestock-Poultry Health Division conducts a number of regulatory programs in consumer protection, animal health and the diagnosis of various disease problems in South Carolina livestock. The division's three main areas of responsibility are the administration of the S.C. Meat and Poultry Inspection Programs, the Livestock Health Programs and the Diagnostic Laboratory.

Meat and Poultry Inspection

This department's responsibilities cover the wholesomeness of meat and poultry slaughtered and the food products processed at all processing plants in the state except for a small number of plants that operate under federal jurisdiction. There are 110 meat and poultry plants under state inspection. The full-time staff is six veterinarians, 50 inspectors, a compliance/evaluation officer and two administrative personnel. More than 100 million pounds of red meat and poultry are inspected annually in state plants. The state's programs continue to meet standards that classify it as equal to the federal Meat and Poultry Inspection Program.

Animal Diagnostic Laboratory

The laboratory is staffed by six veterinarians and 11 technicians. It provides diagnostic services in animal pathology, bacteriology, virology and serology for the regulatory programs as well as diagnostic help to practicing veterinarians and livestock and poultry owners in the state. During the year, the laboratory handled more than 3,000 cases and conducted more than 200,000 laboratory tests and examinations.

Livestock Health Programs

Disease control programs have been established in South Carolina to eradicate certain livestock diseases that cause great economic loss to these commodity groups and pose potential public health problems. Presently, our major programs are aimed at the eradication of salmonella pullorum in poultry, brucellosis and tuberculosis in cattle and pseudorabies in swine. During the year we had a number of outbreaks of pseudorabies in swine. As a result of these outbreaks, the state legislature passed a pseudorabies eradication and control law, which was signed by Governor Campbell on May 29, 1988. All livestock going through auction markets are inspected for evidence of contagious and infectious diseases. Regulatory personnel attended 1,271 sales and inspected 312,776 animals. This division furnishes a veterinarian for each public auction of livestock to perform the necessary tests, vaccination and other tasks to ensure that all animals meet intrastate and interstate requirements for sale and movement.

COLLEGE OF FOREST AND RECREATION RESOURCES

Created in 1970, the College of Forest and Recreation Resources is dedicated to promoting the wise management, use and stewardship of the natural resources of the state, region and nation, and to enhancing the quality of life of our citizens through wise use of leisure and creation of pleasing living environments. The college is the center of expertise for two major industrial groups of South Carolina. Together, the forest and recreation/tourism industries contribute approximately \$8 billion annually to the state's economy.

The college's constituent departments of Forestry and Parks, Recreation and Tourism Management offer educational programs from the baccalaureate to the Ph.D. The college has a tripartite mission of education, research and public service. In addition, the Regional Resources Development Institute, created in 1981, operates under the auspices of the college and examines issues in natural resources allocation and community development throughout the state and region.

The college has developed outstanding computer facilities, which are nationally recognized. We are also nationally recognized for our natural resources continuing education programs, which are conducted primarily for the U.S. Forest Service, National Park Service and the U.S. Army Corps of Engineers.

The college directly touches the lives of many South Carolina citizens through the PRTM Outdoor Laboratory. The Outdoor Laboratory is recognized by its peers as the finest facility of its type nationwide. Programs at the laboratory provide camping and other outdoor experiences for physically handicapped children, emotionally disturbed citizens, blind and hearing impaired children, and hemophiliacs. These programs are vigorously supported by citizens, groups and civic clubs throughout South Carolina and provide an outstanding learning opportunity for Clemson students.

Forestry

The Department of Forestry's programs in education, research and Extension are unique within the state of South Carolina. As such, the department plays an important role in educating many of the foresters who manage the 12.5 million acres of forest land in the state. This resource is responsible for more than \$3 billion in annual sales of forest products produced by more than 1,000 wood using industries in the state. To this end, Clemson's curricula in forest management and forest products emphasize the role of the forester as a steward of our forest resources. Research programs emphasize problem solving and gaining full understanding of the forest and its use. Extension programs are designed to be sensitive to the needs of forest landowners with special emphasis on small, private landowners.

Teaching

During the academic year, 19 candidates received the Bachelor of Science degree, 17 in forest management and two in forest products. Twelve graduate degrees were awarded: eight Master of Science, two Master of Forestry and two Ph.D.s.

The department's accreditation with the Society of American Foresters was renewed through 1992 with the submission of an accreditation report in August 1987. This report culminated a year-long review of the department's teaching programs.

New recruiting brochures were developed and printed to attract more undergraduate students into the forest management and forest products curricula. A new slide tape/video presentation that outlines career possibilities in these two areas has also been developed. This program will be used by faculty to recruit S.C. high school students interested in a forest management or forest products education.

Two graduate students were honored with fellowships and awards during the year. The Friends of Aquaculture and Agriculture awarded a \$5,000 fellowship to a graduate student who is developing innovative information technology for communicating forestry information to the state's forest landowners. The department's first Ph.D. graduate in the forest products area received the Wood award from the Forest Products Research Society for his paper on the thermoplasticization of wood, which resulted from his Ph.D. dissertation. His research involved the development of a process that directly converts wood into thermoplastic materials suitable for structural engineering.

A \$25,000 gift from Dr. Otis Causey and his wife, Calista, will be used to establish a scholarship fund for undergraduate and graduate forestry majors. A scholarship fund was also established in memory of Dr. Douglas Phillips, the department's first Ph.D. graduate. To date over \$5,000 has been donated, and the funds will be used to award a scholarship to an outstanding graduate student on a yearly basis.

For the eighth consecutive year, the Forestry faculty taught a three-week continuing education course in silviculture to U.S. Forest Service personnel from throughout the Eastern United States. And for the fifth year, the department sponsored the U.S. Forest Service short course on Sale Area Layout and Harvesting Institute, a six-week course which attracts federal foresters from throughout the East.

Research

Research in the Department of Forestry is undertaken in the general areas of forest productivity, forest resource management and forest products utilization. Funds to support these efforts come from state appropriations, federal McIntire-Stennis funds, and outside grants and contracts. During the past year, outside funding amounted to over \$800,000. Also, the faculty, staff and graduate students in the department produced over 50 publications in scientific and professional journals, including four department bulletins and research papers.

Three faculty distinguished Clemson with their election and/or appointment to professional positions. Dr. Michael Taras, head of the department, was elected vice president of the Forest Products Research Society, and Dr. David Guynn was elected president-elect of the Southeastern Section of the Wildlife Society. Dr. D. N.-S. Hon was appointed by Congress to evaluate a new deacidification process for paper conservation which was developed by the Library of Congress.

The forest productivity area is made up of scientists in forest soils, silviculture, entomology, genetics, pathology and tree physiology. Some of the major ongoing projects in this area are the biology and production of little-leaf-affected shortleaf pine stands, the regeneration of cutover piedmont stands to productive pine-hardwood mixtures, intraspecific variation and physiology of loblolly pine to waterlogging, the use of prescribed fire as a primary means of site preparation after clearcutting in southern hardwoods, and a dendroecological analysis of loblolly pine tree ring chronologies.

This last study has involved an exhaustive three-year analysis of the growth decline in southern pines. The results of the study should provide better information on whether the decline is climate related or due to some other causative factor such as air pollutants.

The acid rain research site at the Clemson Experimental Forest, which is one of five southwide sites chosen to study the effects of acidic precipitation and ozone on shortleaf pine and related species, has been under development for the past year. The site will be operational near the beginning of FY '89 and will allow a very sophisticated scientific investigation of the effects of these pollutants on tree growth from seedling to sapling. Over a million dollars in funding over the next few years from the Southern Commercial Forest Research Cooperative will support the continuation of this long-term study.

As part of the University's biotechnology program, the department is concentrating its present efforts in two areas, disease resistance and growth improvement. Tissue culture is receiving major emphasis because of the need to regenerate whole plants from the genetically altered protoplasts. Use of tissue from mature trees is being attempted since the successful application of tissue culture techniques to this material would accelerate tree improvement programs.

Research in the forest resource management area seeks solutions to forest-based, multiple-use problems. Major areas of research include investigation of habitat utilization by wild turkey poults in the Southern Appalachian Mountains, the dynamics of harvesting deer herds in the Coastal Plain, the communication between foresters and small private landowners, and the impact of recreation on vegetation. The National Wild Turkey Federation and the U.S. Forest Service continue to support research on wild turkeys in both the mountains and Piedmont.

Research in the forest products area involves not only the development of new products and processes for forest raw materials, but the marketing of these products in the regional, national and international marketplace. With the addition of a new faculty member in marketing last year, a research problem analysis in wood products marketing is nearly complete. Plans are being formulated to identify marketing opportunities for the substantial expansion of the forest products industry in the state with major emphasis on rural areas and the identification of the best potential export markets for S.C. wood products. Two other major projects ongoing in this area are the correlation of the severity of bacterial infection with physical properties of red oak and the effect of manufacturing parameters on the properties of cement-bonded excelsior board from southern hardwoods.

In wood chemistry, work continues on wood plasticization, the development of cellulose polyblends and the testing of deacidification processes for papers of historical value. A special project to assess the preservation treatments conducted on the USS Cairo, a Civil War battleship in Vicksburg, Miss., is complete, and the National Park Service has contracted with the department to assess the effects of pesticides on historic masonry materials.

Five of the department's faculty are located in the South Carolina Coastal Plain, four at the Belle W. Baruch Forest Science Institute near Georgetown and one at the Forestry Sciences Laboratory in Charleston. Institute faculty sponsored an international symposium on second rotation plantation establishment, which was an in-depth look by a group of international scientists at the long-term effects of forest plantations on site quality.

Plans for a new half-million dollar laboratory at the institute have been drawn, and ground should be broken in fall 1988. Major projects ongoing at the institute follow: evaluation of randomness of pollination and potential for inbreeding in southern pine seed orchards, inbreeding depression in selected populations of loblolly pine, hydrologic monitoring of the Hobcaw Barony, and the ecology of the fox squirrel in South Carolina. The Martin Marietta Corporation sponsored a project that will monitor the effects of injecting organic materials into wells and monitoring their movement in the ground water. Westvaco Corporation continues support for a project studying the effect of harvest, site preparation and planting on pools of nitrogen and phosphorous in the loblolly pine ecosystem.

Extension

Extension Forestry continued to coordinate the Sale Area Layout and Harvesting Institute and Silviculture Workshop for U.S. Forest Service personnel. Clemson University has also been chosen by the Forest Service to develop another workshop for wildlife and fisheries biologists and silviculturists. This workshop will concentrate on forest management and is one of five national training modules for Forest Service professionals. An estimated 300 people will attend this two-week workshop.

The Master Tree Farmer program continues to expand and now counts 72 graduates. This program has moved beyond the pilot stage for South Carolina. Five additional workshops are planned for 1988-89. Master tree farmers receive 25 hours of instruction and agree to spend an equal amount of time educating their peers. The South Carolina

Tree Farm Committee and Clemson University have received funds to develop a manual on implementing a Master Tree Farmer Program in other states and territories.

With the increased use of herbicides in forest management, Extension has undertaken an effort to establish a variety of demonstration areas on the proper use of herbicides in our environment. In addition, a ground application workshop was held with approximately 100 applicators in attendance. An application manual for herbicides has been drafted and is being reviewed for use as a southwide publication.

Parks, Recreation and Tourism Management

Teaching

Instructional personnel are dedicated to excellence in education at the bachelor's, master's and doctoral levels. Professional preparation for careers in public and private leisure-service agencies include: county and municipal leisure services; state and county recreation resource management systems; therapeutic recreation settings; and the broad field of travel and tourism management.

Highlights within the department's instructional program for 1987-1988 program included:

- The Ph.D. program has already reached the maximum enrollment projected for this degree.
- Course refinement and new course development continues to reflect adjustments in the respective fields.
- Increase in student credit-hour production reflects an increase in departmental undergraduate enrollment and marketing of PRTM courses to non-majors.
- Adjustments are being made in course sequencing to reflect course offerings as demands change.
- Faculty development is keeping pace with the growing student demand for the travel and tourism emphasis area.

Public Service/Research

Research dollars have been allocated to projects that can be applied to local problems in South Carolina. This is especially true for recreation site planning and developing guides for marketing plans in S.C. tourist regions. Faculty continue to actively pursue research that will bring national visibility to Clemson and South Carolina. Data from a recreation survey were obtained allowing Clemson to attain contracts for analysis of these data. This could lead to recognition as a national recreation data depository and analysis center.

Faculty made presentations at nine national and seven regional meetings. Graduate student presentations were encouraged. Thirty-seven publications were generated with about one-third appearing in national refereed journals. Faculty are continuously requested to serve as referees of research publications and on editorial boards of professional journals.

The National Park Service Cooperative Research Unit, administratively housed in this department, has increased involvement of this faculty and was instrumental in

development of a cooperative research agreement with the University of Waterloo, Canada. One faculty member spent half of his time on an IPA with the Corps of Engineers. Visibility in tourism research is projected through the Recreation, Travel and Tourism Institute, which has now begun active solicitation of nonappropriated funds to enhance research endeavors.

Public Service/Extension

The department's commitment extends beyond involvement with undergraduate and graduate students to include a continuing successful program — College Week for Senior Citizens. During 1988 this program served over 400 citizens from South Carolina and the surrounding region and generated in excess of \$57,000 in income. Tourism-related extension activities were assigned under the administration of the Recreation, Travel and Tourism Institute (RTTI). Non-publication extension requests actually decreased in number from 57 in 1987 to 47 in 1988. This was due in large measure to the distribution of the handbook published through RTTI in the fall of 1987 which included models for community tourism feasibility planning and economic impact assessment for festivals. Many requests in previous years had been for this kind of assistance.

Even so, classroom projects were again used to develop community tourism feasibility studies for 13 communities, 11 in South Carolina and one each in Georgia and West Virginia. Three of the S.C. communities had previously asked for such a study.

The 80-page handbook, *Small Town Tourism Development*, has proved to be most popular. It is now in its fourth printing and has been supplied to organizations and individuals in 14 states and three foreign countries (Canada, France and New Zealand).

Extension/research projects coordinated through RTTI included studies on Beaufort County tourism impacts, Hilton Head Island beach users, post-Labor Day school opening impacts in South Carolina, Clemson visitor profiles (in progress) and military facility recreation plans (in progress).

RTTI has published seven documents during the past year:

- Prospectus RTTI 1987/88-0.
- Small Town Tourism Development RTTI 1987/88-1.
- Beach Users Survey: Hilton Head Island RTTI 1987/88-2.
- The Impact of Tourism on Beaufort County RTTI 1987/88-3.
- Post-Labor Day School Opening in South Carolina: An Impact Study RTTI 1987/88-4.
- Hospitality and Tourism Invitational Proceedings RTTI 1987/88-5.
- Interrelationship Between Education Institutions and Alumni Travel Programs.

The 1987 Hospitality and Tourism Invitational was conducted under the auspices of RTTI, as was a "brainstorming" session set up at the request of AT&T. The latter produced a major pilot project (Dial-a-Tutor) involving AT&T and several departments on campus.

Outdoor Laboratory

Use of the Clemson University Outdoor Laboratory continues to increase. Capacity residential camp enrollments for special populations occurred during the summer

sessions. In September two weeks of Senior Adventure Camp attracted over 100 senior adults from South Carolina. Growth was realized in service to groups and organizations throughout the non-summer months. During the 12-month period, seven residential summer camps served over 800 handicapped children, teenagers and adults, and 220 other groups totaling 12,295 persons. Examples of groups that attracted national participation included the U.S. Forest Service, three workshops sponsored by the Department of Building Science, and two College of Nursing conferences. Residential environmental education programs were conducted by the Outdoor Laboratory staff for elementary children from Morrison, Central and East End schools.

The South Carolina Jaycees again raised \$75,000 for Jaycee Camp Hope at the Outdoor Laboratory. They distributed this amount between summer operations (\$23,000), Rainbow for Hope (\$25,000), a new brick deck for Kresge Hall (\$10,000) and smaller amounts to the program. They also presented \$4,500 additional money to the Rainbow for Hope Campaign to bring that balance over three years to the pledge level of \$75,000.

The Sertomans completed the fund-raising effort for Project Splash (\$152,000), and work began on the aquatic facility in December. The dedication was held May 29, 1988, at the Outdoor Laboratory, and the complex was opened for aquatic activities during the first week in June. Sertoma also continued to support the camping program by recruiting 240 children and paying their camping fees (about \$34,000).

The Lions organization, particularly the Mid-Day Club of Anderson, continues to sponsor Camp Lions Den for the visually impaired. Additionally, they gave a \$1,000 gift to both Rainbow for Hope and Project Splash. Camp Running Brave (for hemophiliacs), Camp Paupi-Win (for adjudicated youth) and the Muscular Dystrophy Camp were also conducted at the Outdoor Laboratory during the summer of 1987 and continued in 1988.

Rainbow for Hope, the endowment program for the Outdoor Laboratory, experienced a fantastic year. In September the Board of Directors presented Clemson University with a check for \$100,000. Phase I was completed, and Phase II, with a goal of \$150,000, was kicked off July 14, 1988.

As the year ended, recruitment was under way to select a recreation coordinator. Also, a new food service assistant manager was employed during the past year. Each of these positions will allow better service to Outdoor Laboratory guests. Attention will continue to be focused on additional needs including road resurfacing, a new maintenance facility, an addition to the superintendent's house and cabin renovation.

Professional Development Program

Programs and courses have been developed and provided for South Carolina Continuum of Care, U.S. Forest Service Data General training, National Recreation and Park Association, youth computer training, U.S. Forest Service recreation management, Army Corps of Engineers, National Park Service and senior citizens. These programs served approximately 800 clients, grossed \$158,000, and were staffed by existing faculty, support staff and graduate assistants using outside speakers when particular expertise was necessary.

Regional Resources Development Institute

Created in 1981 as the Energy and Resource Development Institute, the Regional Resources Development Institute (RRDI) is a cooperative venture between the Southern Appalachian Research/Resource Management Cooperative (SARRMC) and Clemson University. The institute's purpose is to stimulate and coordinate research in the areas of natural resource allocation and management, energy conservation, conflict management over natural resource uses, regional tourism assessment and development, and natural resource policy assessment. RRDI's projects involve scientists and graduate students of SARRMC-member organizations and involve site studies throughout the entire Southeastern United States. This unique arrangement allows an exchange of ideas and skills between the National Park Service, U.S. Forest Service, TVA, U.S. Fish and Wildlife Service, the University of Georgia, Western Carolina University, North Carolina State University, the University of Tennessee and Virginia Tech with Clemson.

In January 1986 RRDI initiated a program entitled South Carolina Today & Tomorrow, which will be a major thrust through the 1990s. The programs of this initiative will examine quality of life issues in the context of regional development. The program is based upon citizen input and participation in the economic development of their communities, counties and regions within South Carolina. Through this new program, RRDI plans to serve as a catalyst for faculty and graduate students interested in improving the quality of life, allocation of resources and citizen participation in regional development in South Carolina and the Southeast.

To approve our position for the South Carolina Today & Tomorrow program, RRDI has joined the Southern Growth Policy Board (SGPB) as an associate member and has compiled a regional database to accommodate the conduct of area impact studies. This program has received support from the Appalachian Regional Commission.

The institute completed the following reports during the 1987-88 year:

- Assessment of Potential/Impacts at the Congaree Swamp National Monument. National Park Service.
- Aesthetic Impacts of an Aerial Tram at the Coley Creek Pump Storage Facility in Oconee County, S.C. Duke Power Company.
- Assessment of Visitor Carrying Capacity at Fort Sumter National Monument. (draft) National Park Service.
- Assessment of Impacts Associated with Dredging on the Chattahoochee River National Recreation Area. National Park Service.
- Crescent Region: An Atlas of Selected Characteristics of Counties Along the I-85/I-20 Corridors. Appalachian Regional Commission.
- An Atlas of Selected Characteristics of Counties of the Southern Appalachians. SARRMC.

Scholarly publications associated with the institute include:

- Three referred journal publications.
- One popular magazine article.
- One book with A. Jubenville, Univ. of Alaska, and B. Twight, Penn. State.
- One book chapter.

Workshops:

- Research Needs for a Forested Wetlands Program (with George Kessler in support of Don Hook's forested wetland research project).
- Two workshops on issues for protection and management of coastal estuaries. (Supported by Sea Grant).
- Co-sponsor of the Second Conference on Social Science in Resource Management, June 6-10 at Urbana, Illinois.
- Presented Clemson portion of the 1988 Legislative Institute in Columbia on South Carolina: Today & Tomorrow.

Grant and funding activities:

- Assessment of Boat Traffic in the St. Mary's Georgia Area. National Park Service, \$69,000.
- Establishment of a Cooperative Program and Enterprise Market at the John De La Howe School. \$90,000 permanent recurring funds, state of South Carolina.
- Worked with De La Howe to develop bond program of \$700,000 to renovate dairy barn into a country market. State of South Carolina.
- Worked with De La Howe and Aquaculture, Fisheries and Wildlife to establish a demonstration fish-farm operation at De La Howe. \$160,000, State of South Carolina.
- Proposal to S.C. Sea Grant to establish a public agenda development project to increase awareness and support of estuary protection activities. \$64,000, pending review.

RRDI was part of the team that developed an NSF proposal to support increased involvement of minorities in math, science and engineering through the Center for the Study of the Black Experience in Higher Education (in last review cycle).

Computer Lab

The fourth full year of operation for the college's IBM Microcomputer Laboratory was successful. As well as instruction for undergraduate and graduate students in the college, personnel from the National Park Service, USDA Forest Service, U.S. Army Corps of Engineers, Office of Professional Development in the College of Commerce and Industry, Continuing Engineering Education, the National Recreation and Park Association, and representatives from private industry used the laboratory for computer skill enhancement. Additionally, the PRTM Department sponsored the third Computer Camp for Youth attended by nearly 50 youth in grades 5 through 12. Offered for the first time this year was Computer Academy, a program for college-bound high school students. Actual use of the IBM Lab exceeds 20,000 participant hours with over \$15,000 in rental and camp-generated income. This income allowed for the purchase of additional computer hardware and software to further enhance the college's ability to incorporate personal computer technology into the management of today's varied and extensive leisure and forestry industries.

Courses have been developed within the college devoted to the use of the personal computer as a management tool; college courses have been identified that utilize

components of personal computer technology; and new state and national workshops have been conducted. Eight courses within the college use the IBM Computer Lab.

A cooperative effort between the college and the USDA Forest Service resulted in the establishment of a Data General Computer Lab in March 1988. The DG computer system is used by the Forest Service nationwide, and the DG training facility at Clemson was the first in the nation. It allows faculty and students access to the Forest Service's system for research and communication purposes while allowing the college to offer computer training opportunities to Forest Service employees. Space is provided by the college, and all equipment (valued at more than \$130,000) was provided by the Forest Service. In the first three months of operation, the DG Lab has accommodated 10 training programs constituting nearly 7,000 participant hours.

The College of Forest and Recreation Resources is committed to becoming the technological leader in both the leisure service fields and forestry. The utilization of the new IBM and DG Computer Labs is a major step in reaching this goal of technological excellence.

ACADEMIC AFFAIRS

Clemson University Libraries

Introduction

During 1987-88 Clemson University Libraries became a true "library without walls." Unfortunately, prices of periodicals and serials continued to be unbounded. These two events combine to broaden the collections beyond the walls of the library, but to limit the resources available within those walls.

This year Clemson University Libraries began to implement programs that have been described by leading professionals in the field as "libraries without walls." Basically, this concept involves developing access to information by the user without the user having to physically be in the library. Automation, database developments and cooperation of the Division of Computing and Information Technology have been key to this initial work. Clemson University is one of only three institutions in the Southeast having progressed to this extent. The other two institutions are Georgia Institute of Technology and Vanderbilt University.

On the other hand, as have many of our peer libraries around the country, Clemson University's libraries continue to suffer dramatic increased costs for the staple of our collections, periodicals and serials. Price increases, particularly by a few select European publishers, and the continued devaluation of the U.S. dollar have restricted the ability of the Libraries to expand the physical collections. The impact of price increases this year necessitated the Libraries' entire budget increase to be used to maintain the current level of subscriptions and restricted the purchase of monographs to approximately half that bought in 1985-86.

Services

The concept of "library without walls," providing information to the user at the user's

site, began to materialize with the Clemson University Libraries during 1987-88. For the first time, library users had access to bibliographic information on materials not necessarily housed in the University Libraries. The source of this data was the AGRICOLA database made available on the new system named DORIS (Document Online Retrieval Information System). AGRICOLA is the agriculture database produced and maintained by the National Agricultural Library. This database was provided by the College of Agricultural Sciences with funds from a grant from the Phillip Morris Company. Several local databases were created or adapted for use with DORIS. The minutes of the Faculty Senate are available on DORIS as well as a directory of faculty and students.

DORIS is based on software leased from BRS, Inc., with funds provided by the Division of Computing and Information Technology. In addition, DAPS provides the programming support needed to load the databases and to make the system more user friendly. Clemson University is one of three universities in the Southeast using this software to provide faculty, staff and students access to bibliographic indexes and abstracts from terminals remote from the Libraries. The current state-of-the-art for library automation for index and abstract information is based on CD-ROM technology, which, to date, means the user must sit at a particular workstation in the library to gain access to index and abstract information. Clemson University is attempting to leapfrog that technology, where possible, to allow access to the same data from terminals located throughout the campus and state.

Indication of the impact of this library without walls approach can be seen in the increasing number of items borrowed from other libraries as well as the number of items loaned to other libraries. During 1987-88 we borrowed 16.5 percent more items than the previous year. Another indicator is the 10 percent increase in the number of do-it-yourself searches made during the year.

Service was improved in the Sirrine Library by increasing the hours of operation 4.5 hours on Sundays, bringing the total number of hours open to 75 per week.

In the Gunnin Architecture Library, procedures were established for library reference and document delivery to participants in the College of Architecture Charleston Program. The college has acquired a Macintosh microcomputer to be housed at the Charleston site to provide students with access to Clemson's LUIS and DORIS systems, and the College of Charleston Online Library Catalog, as well as the capability to communicate with the Clemson Libraries via CUFAN. This will greatly improve access to library information for the students located at the Charleston site.

Several research guides were published during the year. One of note, because it may be trend setting, was the Career and Employment Information guide. This particular guide was funded jointly by the Libraries and the Career Services Office.

Two major areas of concern for improved services are microform reading and photocopier services. Services in both areas have suffered, and plans are under way to resolve the problems. A new microform reader/printer was purchased during the year, and an electronic technician position was included in the Libraries' budget request for 1988-89. The position was approved, and we anticipate employing a technician early in the new fiscal year. This position is needed to maintain the heavily used microform equipment as well as a host of other equipment within the Libraries.

In an attempt to improve the photocopier service provided by Student Government, we agreed to relocate all copiers in one location on the main level. Student Government will provide students to work in the area to keep the machines in operation. What we thought would be a solution has not met that expectation. The copiers continued to be unavailable numerous times, and often students assigned by Student Government did not work when scheduled. Late in the year, the Libraries proposed to the vice president for student affairs that the Student Government copiers be relocated to other campus sites and that the Libraries assume responsibility for operation of the photocopy facilities within the Libraries. That proposal is under discussion.

Late in the year the Libraries received additional equipment funds to improve its automation efforts. An additional 16 terminals were purchased to be tied to the NAS mainframe to provide access to LUIS and DORIS. Eight of these terminals will be located in public areas for use by patrons in Cooper Library. These new terminals have color screens, and the controller to which they are connected permits each terminal to operate in a multiple session environment. This feature will make it possible for users of these terminals to easily switch between LUIS and DORIS.

Several new services took place in our bibliographic instruction efforts. Our workbook produced for use by English 101 and 102 students will be published by a commercial publisher, and the Libraries will receive royalties on their sales. Additionally, our staff extended their bibliographic instruction effort outside the University last year and provided instruction to students at Daniel High School and Edwards Junior High School. In addition, the Pickens County school librarians used one of their in-service training days to visit the University Libraries.

Collections

The key development with the collections of the Libraries was the negative impact of continually increasing costs of periodical and serial subscriptions. This problem is not unique to Clemson, although we face it to a greater extent than many institutions because of our particular mix of curricula and research interests. The end result was the second year in succession in which new periodical subscriptions were ordered. Furthermore, the level of monographic purchasing was limited to approximately half of that purchased in 1985-86. To deal with the problem, a serials review project was initiated and is in full operation with the results expected before the beginning of fall 1988. The objective of this review is to involve faculty from all the departments to help the Libraries determine which periodical and serial subscriptions must be maintained to protect the teaching and research of the University. The result of the review will be a list of titles of periodicals for which subscriptions may be cancelled. The cancelling of these titles will provide the funding necessary to increase the number of books that can be purchased as well as initiate subscriptions to new periodicals.

As we prepare to remove card catalogs, it is critical that library users have access to all of the bibliographic information in LUIS which has been available in card form. During the year, our Cataloging Unit completed the project to convert the bibliographic records of all our serial titles. In addition, they have added to these bibliographic records information informing the user of the volumes and years held by the Library. Providing this information in LUIS permits the Libraries to eliminate the serial visible file, which required a great deal of maintenance and provided only restricted access.

Our map collection was expanded during the year by adding the 1:100,000 scale series maps of the eastern portion of the United States.

Another effort under way to make our collections more accessible is the minimum level cataloging project for planning documents and bachelor papers housed in the Gunnin Architectural Library. This project is well under way, and nearly 500 of the planning documents have been cataloged.

Another effort that made significant strides during the year was the development of an automated catalog system for the collection of art and architecture slides housed in the Gunnin Library. The bibliographic information for each slide and slide sets will be entered into a separate file in NOTIS and will be accessible by all terminals. This will make these 70,000 slides accessible to users outside the College of Architecture.

Automation

The implementation of DORIS was the automation activity of the year. Continuing maintenance and upgrading of NOTIS also was a significant automation effort during the year. The Library is indebted to its staff as well as staff from DAPS, who are critical to the success of our automation efforts.

DORIS is just beginning to have an impact on the use of the collections of the Libraries as well as on interlibrary loan. Plans are well under way to add six significant databases early in 1988-89. Five of these databases will be expanded versions of the laserdisk system now in the Libraries known as InfoTrac. By placing these databases on DORIS, we will provide access to this same information but from any terminal, not limited to the six terminals now connected to InfoTrac. The sixth database will be the bibliographic records of all the government documents distributed since 1972. We have applied for a U.S. Department of Education Title II-D grant to make this database available to all of the libraries of South Carolina. This database will provide access to our collection of U.S. government documents, which now numbers over 600,000 items. It will be the first time the user has had such access to this wealth of material.

This was the first year University units were permitted to retain lapsed salary funds and given a high degree of freedom as to how they may be used. Within the Libraries, units having lapsed salary funds were given 70 percent of such funds to use at their discretion. Most units used these funds to purchase microcomputer equipment and software. This has allowed the Libraries to move toward fully utilizing the campus network for electronic messaging.

Record Management and University Archives

The most significant occurrence in this area was the completion of the Records Retention Center in the basement of Barre Hall and its occupation by the Records Manager and her assistant. This new facility will hold over 4,500 cubic feet of inactive University records, which will relieve the space required by University offices to store this material until it is eligible for destruction by the records retentions schedules. In June 1988 only months after opening, this facility contained 1,587 cubic feet of records. This operation has a limited staff, yet it is responding well to numerous requests from University offices to schedule records and to assist with immediate storage problems.

The University Archives continues to grow, this year adding almost 800 cubic feet of departmental records, 186 photographs, and assorted memorabilia. This staff arranged 68 cubic feet of material and described another 26 cubic feet.

The number of manuscript accessions increased by over 40 percent over the previous year; however, most of these were small collections, many coming as a result of the increased work of the University archivist and the Sistine project archivist, who turned up many small, and in some cases, important collections. Some examples of collections added include the papers of John K. Cauthen, former head of the South Carolina Textile Association, and the records of the Textile Hall Corporation in Greenville, which came with the help of Louis Batson Jr.

Library Usage

The use of the Libraries continued to increase. Sistine Library, for example, showed a dramatic increase in number of items borrowed, going from 8,847 to 10,525. Inter-library loan continued to increase in both the number of items borrowed as well as loaned to other institutions. We continue to be a net lender; however, as greater access is provided our users to materials housed elsewhere, the number borrowed continues to approach the number loaned. The library borrowing the greatest number of items from us continues to be WESTVACO in Summerville. We are exploring ways to support each other's efforts.

Fund Raising

During the year the Shirley Endowment was again increased by generous gifts totaling more than \$300,000, taking that endowment to approximately \$800,000 with a commitment that it will exceed one million dollars. Also, a new President's Club member committed his gifts for the use of the Libraries.

Staff Development

The Libraries Classified Staff Council, which was organized last year, became completely operational this year. Major accomplishments of this organization were substantial. A committee of the council organized several in-house workshops on office automation support using the Apple Macintosh line of computers. These workshops enabled nearly all staff to get hands-on learning in the use of the Macs. Semi-annual, librarywide staff meetings were set up with the director, to improve overall communications on issues of interest to staff. The Library Staff Manual was revised, a suggestion box was set up for users, an activities and events committee was organized, staff orientation was improved, and better input was made to other organizations on campus as a result of the efforts of this council.

Conclusion

Overall, the Libraries continued to make significant progress in achieving the research, instructional and public service missions of the University. Future efforts will concentrate on continuing to expand upon the libraries without walls concept by adding access to databases available on other computers, by making the in-house collections more accessible, and by finding additional sources of funding to expand the collections and facilities of the Libraries.

Library Statistics 1987 - 1988

Collections				
Books/Journals	Accessioned	Withdrawn	Cataloged	TOTAL
Cataloged	17,435	2,767	14,668	663,439
Uncataloged:				
Gunnin				2,154
Sirrinc				3,268
				668,861

Documents and Reports 656,130

Microforms	Microfilm	Microfiche	Microcard	Vol.Equiv.*
Public Documents	2,178	695,191	----	71,697
Other	20,159	507,533	31,499	74,062
Total	22,337	1,202,724	31,449	145,759

GRAND TOTAL

Printed Materials	1,470,750
Slides (Gunnin)	71,022
Maps (Cooper)	16,195

Current Serial Subscriptions	1986/87	1987/88
Periodicals	5,854	5,811
Other Serials	1,122	1,089
	6,976	6,900

*Microform volume equivalents are determined by counting microfilm reels as one volume and ten microfiche or microcards as one volume.

Circulation

Door Count of Users

Cooper	757,496	771,290
Gunnin	74,527	73,593
Sirrinc	n/a	n/a
	832,023	844,883

Books Circulated

Cooper	204,915	218,865
Gunnin (Excluding slides)	12,804	16,109
Sirrinc	8,847	10,525
	235,377	245,499

Reference Services

Inquiries

Directional	4,103	3,845
Reference	38,590	37,891
Research	473	489
	43,166	42,225

Computer Searches

Do-It-Yourself	1,516	1,680
Reference	68	36
Research	206	139
	1,804	1,858

Interlibrary Loans

Loaned	6,076	6,679
Borrowed	5,588	6,510
	11,664	13,189

Computing and Information Technology

Computer Center

The past year was one of the most significant in the history of the Computer Center. Over Thanksgiving 1987 the Computer Center finally solved the space and environmental problems which had plagued it for the previous decade. The computer mainframe operations of the center were moved from the basement of the Poole Agriculture Center to a new Information Technology Center (ITC) eight miles from campus in the Clemson Research Park. The move was accomplished with no disruption of normal service and was transparent to the general computer user. The official opening of the building was held April 25, 1988, with Governor Campbell as the keynote speaker.

The ITC, developed by Keenan/Clemson Associates to center specifications, contains 40,000 square feet of space including a 10,000-square-foot machine room and administrative and programmer office space. The building is protected by sophisticated, computer-controlled security systems which guard against power failures, fire and unauthorized access. Telecommunication lines link the ITC with the main campus, and the computer system appears to the user as if it were in fact on campus.

The center has retained the old computing facility in the basement of the Poole Agriculture Center and renovated it to house the cluster of VAX computers and also the Consulting and Technical Services group. The network and terminal repair groups have also remained on campus.

Computing capacity on the NAS mainframe remained adequate throughout the year. Capacity on the VAX network, however, was not sufficient to meet demand. The center was able to address this problem by obtaining a grant of approximately \$800,000 from Digital Equipment Corporation (DEC) to supplement University funds to buy two of the latest DEC 8800 computers, which were installed on the network in mid-summer 1988.

The number of microcomputers and terminals on the network continues to grow rapidly. The center installed additional public access facilities in 1987-88 but is considering stabilizing the number of microcomputer laboratories at the end of the 1988-89 year. There are now laboratories in most major academic buildings, and it is felt that it is more important to keep these facilities up-to-date rather than continue to add more but be unable to properly maintain them.

The volume of service provided to outside customers remained high during 1987-88 with revenues of approximately \$3.5 million. There is likely to be a sharp decline in revenue in 1988-89, however, as the center implements changes in its charging model recommended by federal auditors and the center's consultants. These changes will reduce rates to all customers to properly reflect the increased efficiency of the center in providing computing service.

The Computer Center is dedicated to providing the best of computing service to the University and the state. While center staff have been extremely innovative in obtaining equipment and research grants, service contracts and in maximizing the efficiency with which existing resources are used, keeping Clemson computing ahead of that of other institutions will become increasingly difficult as those institutions increase their investments in high technology. High technology is seen to hold the key to success for a major

research university, and no university with aspirations to greatness can afford to allow its computing and information technology facilities and services to slip behind. If Clemson is to move into the front rank of the world's research universities, its commitment to and investment in computing will have to increase.

Information Systems Development

The Information Systems Development (ISD) group increased its revenue for the sixth straight year despite increased competition in the systems development marketplace and the winding down of two major contracts. While the overall condition of the organization remains strong, ISD faces some major challenges in the years ahead.

Competition for new contracts remains fierce, but has been replaced by competition for personnel as the major problem facing ISD. While ISD has never been able to match industry salaries and some turnover of staff has always been expected, the current discrepancy of about 40 percent between what ISD can pay and the typical industry salary is making it extremely difficult to recruit and retain qualified staff. Staff losses at the most inopportune time have jeopardized at least one major contract in 1987-88. If ISD is to keep its existing contracts and attract new ones, it must maintain a staffing level sufficient to meet contractual obligations.

ISD is in the third year of a three-year contract to provide support for the Medicaid system administered by the South Carolina Health and Human Services Commission (HHSFC). HHSFC has an option to renew the contract for two one-year terms, after which it must be renegotiated or bid. Since this contract is by far ISD's largest, its renewal is important to the stability of the organization.

ISD is also in the final year of a contract to develop a computer system to support the Title IVD Child Support System in South Carolina. The federal government has shown an interest in this system becoming a model for other states. If adopted by other states, it would be a significant source of revenue for ISD for several years.

HHSFC, DSS, the Department of Health and Environmental control, the TEC system and other state agencies provide the bulk of ISD's business, though an effort is under way to increase the volume of non-state work.

Administrative Programming Services 1987/88

Administrative Programming Services (DAPS) develops and maintains computerized information systems for the University. These systems provide support to all administrative and academic operations. Historically, University systems have been highly centralized and accessible by relatively few people. DAPS is now designing systems to be used by as many administrators, faculty, staff and students as possible. It is hoped that the only barriers to information access that exist will be those imposed by the inherent privacy of certain information.

DAPS follows a yearly information systems plan developed jointly with key administrators. Considering the dramatic increase in the number and quality of information systems used by the University, DAPS has responded well to the challenge of meeting the increased demands for services while maintaining staff at 1978 levels. Briefly, new systems development can be characterized by the concept of information access. That is, information must be made accessible to all members of the University as easily as

possible. Information brokers should be needed only rarely. This philosophy requires that increased emphasis be placed on the privacy of certain information. A comprehensive security data system has been implemented to screen all requests for data.

It is important to note that Clemson does not have several systems development groups as found at most similar universities. DAPS supports the systems activities of all Clemson administrative areas. Also, there is decreasing distinction between the administrative and academic computing networks. Student terminals often access portions of the same databases accessed by administrators. Likewise, administrators have access to resources such as the Library catalog and the document retrieval system discussed below. All students, faculty and staff are now being assigned a computer identifier that is used for course work, electronic mail, and student administrative systems such as Placement and the academic records access system.

A sampling of 1987-88 accomplishments follows :

- Installed the Document Online Retrieval Information System (DORIS). DORIS is used to search information databases produced or acquired by Clemson University. Some databases contain the full text of documents, while others provide citations to documents and publications found elsewhere. DORIS searches every word of documents for words or combinations of words provided by the user. Databases currently available are Agricola (a national database of agricultural publications), minutes of campus organizations, the Clemson directory and the University Stores catalog. Several new bibliographic databases are planned for 1988-89. DORIS uses the powerful BRS/Search software acquired last year by the Computer Center.
- Installed the Online Budget Amendment system that allows authorized individuals at the department or college level to adjust expenditure budgets within certain guidelines. All adjustments appear immediately in the financial database, and an audit trail is automatically recorded.
- Greatly expanded the use of the language Intellect by campus departments. This system is a natural language query facility that provides access to employee records using a free form, English-like language to ask questions. Answers are provided as counts, statistics, or listings in either an online or background mode. Intellect is also used by Undergraduate Admissions, Student Affairs and Alumni Affairs for their respective databases.
- Provided ongoing support and enhancements for about 50 administrative information systems.
- Developed the Student Information Services System that gives every Clemson student access to personal enrollment and general academic information. The system can be used for pre-registration, student career placement, and to view the academic calendar and final exam schedules.
- Sponsored a series of sessions in which information resources available to the campus community were displayed. These sessions, called DAPS Demonstration Days, were attended by over 500 faculty, students and staff.
- In cooperation with the Computer Center, issued a computer use ID to every Clemson employee who did not already have one. This ID can be used to access the new Employee Information System and protected databases in the DORIS

information retrieval system. With approval of the department head, the ID can also be used for a wide variety of electronic mail and timesharing services.

Graduate School

The Graduate School experienced a record number of applicants and enrollees in the 1987 fall semester. A total of 2,709 applicants produced 878 new enrollees. These were a portion of the record enrollment of 2,902.

A new program, the Master of Science in Applied Psychology, was approved by the Commission on Higher Education for implementation in fall 1988.

The Office of International Programs and Services made significant progress during the past year developing programs designed to strengthen its relationships with the international student population on campus. The office grew during the past year from a full-time staff of three to a full-time staff of six, two half-time faculty, two graduate assistants, one undergraduate intern and more than 45 volunteers. Dr. Frankie O. Felder was appointed associate dean of the Office of International Programs and Services. The expanded mission creates opportunities for Clemson to make a significant contribution in international affairs.

The University was awarded two fellowships totaling \$32,000 under the Department of Education's Patricia Roberts Harris Fellowship Program for 1988-89.

Beginning January 1988, Clemson University's new Telecampus program began live broadcasts of graduate-level courses via S.C. ETV's ITFS (Instructional Television Fixed Service) network to viewing sites statewide. Telecampus has established remote receive sites at Greenville Technical College, Lander College, Florence-Darlington Technical College, Winthrop College, Trident Technical College and Aiken Technical College. In addition, Spartanburg Regional Medical Center is offering nursing courses for students in the greater Spartanburg area. The Telecampus program provides means by which the academic needs of adult learners with busy professional and personal schedules can be met. An ultimate goal is to offer entire master's degree programs or perhaps the first year of core courses of a degree program. The College of Nursing, College Engineering and Department of Building Science and Management are among those with programs under active consideration and/or development in this direction.

National Dropout Prevention Center

The National Dropout Prevention Center at Clemson University is dedicated to raising national awareness of the dropout problem and to assisting individuals and organizations involved in dropout prevention in the nation's public schools.

Since its establishment in 1986, the national center has worked actively with organizations and agencies in the public and private sectors. One such organization is the National Dropout Prevention Fund, which provides advisory and support resources for the center's activities, thus forming a unique private/public partnership. The center is also the host agency for the National Dropout Prevention Network, which represents a collaboration of individuals and organizations working on dropout prevention. Fur-

thermore, the center is the home of the South Carolina Dropout Prevention Network, a special program funded by the Governor's Office to establish a strong state collaborative of leaders in education, government, business and the general public.

The center is a unit of Clemson University. The new executive director assumed his position June 1, 1988, and reports directly to the provost. Other staff include an assistant director, a state coordinator and four support staff.

Research and Development

In the area of research and development, the staff completed the following:

- Surveyed education departments in all 50 states and four U. S. territories, 45 national organizations and agencies, and numerous school districts and communities to identify the types of dropout prevention programs in existence and to gather other information for the development of a computer database, a national directory and reports on dropout-related issues.
- Analyzed more than a dozen major reports about the national dropout scene and what should be done about the problem as a basis for staff development programs and information reports.
- Completed a report based on a survey of the education programs in 109 land-grant colleges and state universities to ascertain the degree to which they are preparing teachers to deal with students at risk of dropping out of the public schools.
- Surveyed all 91 South Carolina school districts to identify programs and obtain other dropout-related information to develop a directory and establish baseline data for future comparisons.
- Surveyed 57 attendance supervisors to develop a report on their opinions on various aspects of the dropout problem in South Carolina.
- Initiated the development of a handbook/guidebook for evaluating dropout prevention programs.
- Participated with University staff and other organizations to develop proposals for submission to Kellogg Foundation, General Electric Foundation, BellSouth Foundation, Appalachian Regional Commission, Office of Educational Research and Improvement, and U.S. Department of Education (School Dropout Demonstration Assistant Program).

Dissemination and Information Services

In the area of dissemination and information services, the staff completed the following:

- Developed a computer database describing 200 dropout prevention programs.
- Accumulated over 300 copies of major reports, research studies, legislation, statistics, manuals and guidebooks from all state departments of education, many national organizations and agencies, many local school districts, and various regional labs and centers as the basis of a materials resource library.
- Responded to an average of 200 requests/inquiries each month concerning dropout prevention issues, statistics, program information, professional development and technical assistance.

- Published and disseminated 2,500 copies of the National Directory of Contacts in Dropout Prevention and 800 copies of the South Carolina Directory of Contacts and Programs in Dropout Prevention.
- Distributed over 200 survey reports to attendance supervisors, education deans in land-grant colleges and state universities, and selected state and national parties interested in dropout prevention.
- Entered into an agreement with the National Dropout Prevention Network to serve as its host agency; printed and distributed 130,000 membership brochures on behalf of the network.
- Published and distributed 5,000 copies of the first issue of a quarterly newsletter in collaboration with the network.
- Cooperated with the National Dropout Prevention Fund and the National Academy of Sciences in planning a national symposium for fall 1988 to develop a white paper on dropout prevention.
- Co-sponsored with the Wil Lou Gray Opportunity School Research and Training Center a state forum, "Youth at Risk: South Carolina's Search for Direction," for 90 state leaders in dropout prevention.
- Provided technical assistance to 33 S.C. school districts in proposal writing, which resulted in requests of \$2.5 million of the total \$23 million of the federal funds available under the School Dropout Demonstration Assistant Program.
- Participated as committee or board members on 11 national, state or local organizations involved in dropout prevention.
- Presented or conducted workshops at seven state conferences, two regional conferences, five national conferences, fourteen educational or professional meetings, four civic organization meetings and four state legislative committee meetings.
- Initiated plans to develop Adopt-a-School programs in two New York City high schools.
- Developed a plan to place all S.C. network information and services in the Clemson University Forestry and Agricultural Network (CUFAN), a computer network accessible to all S. C. counties.
- Provided editorial consultation to two national groups developing films on dropout prevention and one organization writing a book on middle school dropout prevention.
- Participated in two television public service programs and two radio interviews; gave interviews to at least ten newspapers and magazines doing stories on dropout prevention.
- Hosted visitors from more than a dozen states and the District of Columbia.

Funding

The center was supported by Clemson University, Exxon Education Foundation, the Appalachian Regional Commission and General Foods Corporation. The S.C. network was supported by a grant from the Department of Public Safety (Juvenile Justice) in the Governor's Office. The S.C. General Assembly appropriated \$500,000 to support the center in FY 1988-89.

Representatives from the center and the National Dropout Prevention Fund prepared a working agreement to guide the operational aspects between the two organizations.

Center staff cooperated with the fund to secure consultants to study fund-raising activities for the center. Additional funds were secured by the fund to sponsor a collaborative effort with the National Academy of Sciences to conduct a national symposium on dropout prevention.

The Strom Thurmond Institute of Government and Public Affairs

The Strom Thurmond Institute is the main program component of The Strom Thurmond Center for Excellence in Government and Public Service. The institute conducts five programs:

- The Thurmond Seminars in Government and Politics
- The Strom and Nancy Thurmond High School Achievement Program
- Institute Lecture Series
- Distinguished Lecturers Program
- Governmental Research Program

Since its inception in July 1982, the institute has sponsored public programs featuring leading opinion makers addressing various topics, including the proposed balanced budget amendment, the nuclear arms freeze, NATO, agriculture policy, energy policy, domestic terrorism, natural resources, and volunteerism and civic participation. Eminent speakers in the institute programs include Senator and Mrs. Thurmond, Senator Ernest Hollings, Senator Joe Biden, Vice President George Bush, Reverend Jesse Jackson, Prime Minister Eugenia Charles of Dominica, Ted Turner, members of the Clemson University faculty, and prominent scholars and leaders representing varied philosophies and views on issues of the day.

The institute has on-going research in the areas of local government, water resources, energy emergency policy, community needs assessment and defense studies. The institute is in its fifth year of work for the South Carolina Water Resources Commission to develop a long-range water use policy for the state.

The institute publishes *The Review of Regional Studies* for the Southern Regional Science Association, a lecture series, working papers, conference and symposia proceedings, and research reports.

Private contributions of \$6.5 million have been raised for the institute building, located at the center of the University campus and scheduled for completion in early 1989.

Undergraduate Studies

The Undergraduate Studies Office is responsible for undergraduate academic programs and curricula, academic standards, scholarships and awards, Universitywide lectures, new faculty-staff orientation, summer sessions, the Clemson Career Workshops, the Junior Scholars Program, the honors program, special post-graduate scholarship programs and the Clemson University Centennial.

At the beginning of the year, new undergraduate programs were begun in landscape architecture and in fine arts. These programs culminated a number of years of planning

and have strong support from their appropriate industries in South Carolina and in the Southeastern region.

The Clemson Career Workshops bring academically outstanding minority students to campus before their junior and senior years in high school. The 1988 summer program included 367 students at both levels. Clemson expects approximately 42 new freshmen recruited by this program to enroll in the fall of 1988.

The Honors Program enrolled 5 percent of the undergraduate student body in 1987-88. Sixty students were graduated with senior departmental honors in December, May and August. Two Clemson seniors received Fulbright Scholarships for foreign country study in 1987, bringing the number to 29 in the past nine years.

The Junior Scholars and Summer Science and Engineering Programs bring academically talented students who are between the ninth and twelfth grades for the Summer Academic Enrichment Program. The program, which is in its fourth year, enrolled 300 students this year.

April 6, 1988, officially began the Clemson University Centennial. Flagraisings and other celebrations in all counties of the state emphasized the statewide campus that Clemson has through the County Extension Offices and the Research and Education Centers. Concerts, theatrical productions and a lecture by Beverly Sills were the highlights of the Centennial's first emphasis — the University and the Arts. The Centennial will continue through November 27, 1989.

University Research

The Office of University Research provides information and assistance concerning all aspects of the University research effort to faculty members, departments, colleges and other administrative units. The office helps prepare and submit applications for sponsored research, instruction and public service programs. During 1987-88 the office processed 724 faculty proposals.

The office also provides University liaison between the institution and all public and private, national and local organizations or entities concerned with any aspect of research support, regulation or administration.

Guidance and executive support were provided to the University Committee for the Protection of Human Subjects, the Biomedical Research Support Grant Committee, the University Research Grant Committee, the Animal Research Committee, the Institutional Biosafety Committee and the Clemson University Patent Committee.

VICE PRESIDENT FOR ADMINISTRATION AND SECRETARY OF THE BOARD OF TRUSTEES

The position of vice president for administration was created August 1, 1985, and the first incumbent was Hugh J. Clausen.

The director of public safety, who supervises the police and fire departments, and the director of parking and vehicle registration report to the vice president for administration. The University municipal judge relies on this vice president for administrative and logistical support. The internal auditor reports to the secretary of the Board of Trustees, who, in turn, reports directly to the chairman of the Board. The vice president for administration assumed supervisory responsibility for Human Resources in October 1986 when the Office of the Assistant to the President for Human Resources was transferred to the vice president for administration and the title of the supervisor of the Office of Human Resources was changed to assistant vice president for human resources. On July 1, 1987, the Office of Public Affairs became the newest area of responsibility of the vice president for administration.

The Office of the Vice President for Administration and Secretary of the Board of Trustees is located in Sikes Hall. Expenditures for the fiscal year ending June 30, 1988, were \$2,358,519. (The Department of Parking and Vehicle Registration became an auxiliary department July 1, 1987.)

Fire Department

During 1987-88 the Fire Department responded to 451 fire alarms; 27 percent of the fire alarms were off-campus alarms. A total of 3,450 emergency medical alarms were answered.

On-campus fire property damages for this reporting period totaled \$13,325. Property damage in the city of Clemson was \$494,510 compared to \$750,000 for the same period last year.

An arson fire at the Calhoun Mansion on May 30 caused the most significant on-campus fire loss in recent history. A fire sprinkler system in the structure activated to confine the damage to the area of origin. Building damage was estimated to be \$10,000. The cost of repairing the damage to the historical contents has not yet been finalized.

Significant improvements in the rate of malicious false fire alarms was made during the last six months. Forced evacuation of building occupants, stepped up enforcement of fire safety statutes and fire safety education programs netted a 24 percent reduction in these crimes.

Additional training standards have been added to the CUFD-EMs' monthly training schedule to comply with federal and state requirements for responding to hazardous materials incidents. Also, monthly training for emergency medical personnel has been implemented to meet new D.H.E. requirements.

Fire prevention activities have increased significantly since the hiring of a new fire safety officer. In addition to inspections, the new F.S.O. has been participating in facility construction projects, fire safety training for University staff and students, and maintaining the University's inventory of fire extinguishers.

The CUFD-EMs led all of the fire services in South Carolina by raising \$4,776 for the Muscular Dystrophy Association during the past year.

Human Resources

The Office of Human Resources is charged with coordinating and directing the efforts of the University to meet the objectives of affirmative action, equal employment opportunity and the goals of the state desegregation plan.

The department continues to be actively involved in recruiting black faculty and staff, as well as graduate students. The academic year 1988-89 will include five additional black faculty and several appointments of blacks in professional-level staff positions. These appointments were brought about through effective recruitment programs reflecting the administration's expectation that the faculty and staff reflect the diversity of society itself.

On July 1, 1988, the Center for the Study of the Black Experience in Higher Education was established at Clemson University as a result of many months of program development during the preceding year. The center is a resource from which information, research and programs on factors affecting the educational decisions of blacks will be made available on a nationwide basis.

Also of particular note is the forthcoming Vital Issues II: Racism, Prejudice and Separatism in Higher Education conference developed through this office. With the relevance of its focus, it is expected to attract higher education administrators from across the country and will establish Clemson as a leader in the field.

Internal Auditing

The staff of the Internal Auditing Division consists of six members: a director, an audits manager, an EDP specialist, two staff auditors and an administrative assistant. The director reports administratively to the secretary of the Board of Trustees. Departmental expenditures for the year were \$240,270.

The division provides an ongoing, independent audit function for the University as a service to management. Audit parameters include financial, compliance and operational review, as well as special requests.

Municipal Judge

The staff of the University's municipal judge consists of the judge and an administrative specialist, who serves as judge in the regular judge's absence. Formerly known as the University recorder (Recorder's Courts were abolished in 1980 by act of the General Assembly), the judge for the municipality of Clemson University hears appeals and renders decisions on all campus parking violations brought before the court, tries all persons charged with violating any ordinance passed by the Board of Trustees and any state laws that fall within the jurisdiction of the municipal judge (any crime or traffic violation for which the maximum penalty that can be imposed does not exceed \$218

or 30 days in jail). The municipal judge also issues bench warrants, search warrants and arrest warrants for incidents arising on campus. Expenditures for 1987-88 were \$31,293.59.

Parking and Vehicle Registration

The Department of Parking and Vehicle Registration became an auxiliary department July 1, 1987. The department maintains parking and traffic records and issues University parking decals. For the year 1987-88, 189,723 decals were issued and \$158,632 in vehicle registration revenue was deposited. For the same period, 58,090 parking tickets were issued by the University Police Department generating \$451,337 in revenue. The Student Traffic Review Board heard parking ticket appeals from 1,831 students involving 2,527 tickets, or about 4.4 percent of the tickets written.

Police Department

During 1987-88 the Police Department responded to 6,254 calls for service, a 7 percent decrease from last year. Property losses reported from criminal activity totaled \$168,891. Crime rate statistics reported in SLED's Crime in South Carolina 1987 indicated a 22.2 percent increase in violent crimes and 11.5 percent increase in non-violent crimes reported at Clemson University in 1987. During this same period, crime reported in Pickens County decreased 12.9 percent and 0.5 percent in violent and non-violent crimes, respectively.

The increase in crime at the University resulted in the confiscation of 11 firearms, an unusually high number. Police efforts during the year resulted in 292 arrests and \$20,104 of stolen property (12 percent) recovered. Investigation of 120 fraudulent checks cases assisted in the return of \$8,000 to the University. The department also provided services for 141 special events on campus in addition to normal activities.

Investigation Division

The Investigation Division assembles facts and evidence to document a reported incident, identify offenders and assist in the administration of justice. This division also performs background investigations, coordinates the protection for VIPs to campus when requested and helps present public safety programs. During 1987-88 the investigators operated with an average case load of 145 cases. Senior investigator Jim Brummitt served as president of the South Carolina Campus Law Enforcement Association. Significant accomplishments of the division include:

- Drug-related investigations yielded 11 arrests and the seizure of \$30,000 cash and two firearms.
- On-going investigation of the arson of the Calhoun Mansion.
- Investigation and arrest of a subject responsible for making false ID cards on campus.
- Provided dignitary protection for 12 campus visitors.
- Provided Ptl. Ron Howell with specialized training as an investigator in addition to in-service training for all investigators in modern topics of concern including AIDS, narcotics and Satanism.

Uniformed Patrol Division

Uniformed patrol officers move about campus to deter and detect criminal activity, preserve order, direct traffic, investigate accidents, and enforce state laws and University parking regulations. Additional services provided by the division include transporting sick/injured students to the infirmary, monitoring intrusion and fire alarms, providing dispatch service for fire, EMS and evening dispatch for FMO, and maintaining traffic signs and street markings. Significant accomplishments of the division include:

- The traffic safety program resulted in 1,113 traffic citations being issued. Defensive driving instruction was provided for 26 campus citizens. The initial phase of an Emergency Vehicle Operation training program was completed and provided to all sworn officers.
- Parking enforcement was increased using contract security officers to supplement the department's employees. A total of \$59,111 in parking citations were issued, a 9.5 percent decrease from last year.
- Preventive patrol efforts were hampered last year due to 9,471 hours of vehicle downtime for repairs and the elimination of the patrol officer positions by Ptl. Webb and Ptl. Link in 1986.
- In-service training was provided to all personnel in a variety of topics. Five officers were recertified as breathalyzer operators, all sworn officers were recertified in firearms proficiency, and one officer was certified as an instructor for eventual inclusion in the traffic safety program presentations. Two recently hired officers have not yet been called by SCCJA to receive their basic training certification.

Administrative Division

The Administrative Division is responsible for developing and presenting public awareness programs, the supervision of student police officers, and working with victims of crime by providing services and information to help them cope with the criminal justice system and with the stress caused by victimization. Significant accomplishments of the division include:

Public Safety Programs:

- Provided child safety program services in several community outreach projects and in local schools.
- Revised the Date Rape Awareness program to reflect current trends and increase effectiveness.
- Conducted 55 crime prevention security surveys for departmental units on campus.
- Presented public safety programs to over 1,400 citizens.
- Completed grant applications which, if successful, will help the department generate computer composites of suspects and provide increased services for victims of crime.
- Coordinated the presentation of a departmental in-service training program to improve performance of employees in several areas where weaknesses were identified.

Student Police:

- Student police assisted the department by providing 1,980 hours during special events, 2,062 hours painting street markings, 691 hours of special surveillance operations, and 2,378 hours for athletic events, traffic direction, parking enforcement, dispatch and VIP transport services.

Crisis Response Team:

- The crisis response team consists of volunteers within the department who train together to work as a team when responding to an unusual incident on campus. The primary goal is to contain the incident and provide protection to campus citizens who otherwise might be endangered. During the year, the team participated in three field training exercises to sharpen their skills in responding to barricaded subjects, officer survival as field responders and tactical firearms training.

The end of the year was marked by the arrival of the department's first computer system hardware and the approval for the purchase of five replacement patrol cars. To continue to meet the challenges of the future, personnel and equipment requests must be given high priority as we continue to dedicate ourselves to providing the high caliber of service and protection enjoyed by our campus citizens.

Public Affairs

The Office of Public Affairs maintains contact with the South Carolina General Assembly and state regulatory agencies. The president is provided counsel and advice on activities of the General Assembly by the director of public affairs.

A continuing task for the Office of Public Affairs is to maintain a University presence in the capital city by serving in a liaison capacity with central state government. Furthermore, this department is committed to enhancing the image of higher education with the legislative and executive branches of state government and the public.

BUSINESS AND FINANCE

Business and Finance is responsible for determining the broad policies of institutional functions relating to administration, business and finance, and for managing specific administrative, fiscal and auxiliary functions. These departments are comprised of over 1,000 full-time, part-time and contract employees responsible for managing financial resources in excess of \$40 million.

During 1987-88 Business and Finance was reorganized, consistent with a recently developed strategic plan. In line with the strategic plan's focus on program, rather than department areas, the following are the highlights of the goals achieved in 1987-88:

Governmental Relations

Working in cooperation with other members of the campus community, Business and Finance helped to enhance Clemson's relationships with a variety of its constituencies. Members of the Business and Finance organization stepped up their efforts to establish and renew contacts among strategic state agencies. Communications were enhanced through creating an interadministrative team to produce the first annual "President's Report," a new financial report, a special study and publication in support of the Research Investment Act, and on student fee comparisons with peer institutions.

Budget and Planning

Clemson will celebrate its Centennial year with a budget exceeding \$250 million vs. \$215.4 million during 1987-88. The state of South Carolina has demonstrated a renewed commitment to higher education with 93 percent formula funding versus 88 percent during 1987-88, and the investment of \$5 million in "Cutting Edge" research and economic development programs for higher education institutions. The campus has strengthened its financial foundations by integrating long-range and strategic planning priorities with budgets, by adopting innovative budget management practices, and by encouraging cost containment efforts throughout the University. These efforts, together with the state's new initiatives in higher education, continued improvement in PSA funding for agriculture, and expected increases in sponsored programs and gifts will allow Clemson University to continue to develop a national reputation in a variety of program areas while contributing to the economic development of South Carolina.

Business and Finance's first strategic plan was produced and presented at the president's retreat in the spring, and an update of the campus master plan was initiated. Academic departments received assistance in integrating their Second Century and other plans with annual budget priorities. A preliminary report was presented for consideration at the president's retreat outlining a conceptual framework and steps in further developing the Second Century strategic plan for the University and its future. The division assisted academics in preparing for the upcoming SACS accreditation review. Preliminary steps toward developing a long-range financial plan for Clemson were put in place. Progress was made in determining priorities Universitywide and in returning lapse salaries to departments. Department heads were granted greater discretion in implementing their budgets.

Business and Financial Affairs

Student Registration

A committee was established jointly by the vice president for student affairs and the vice president for business and finance to study the student registration process. Improvements made include a substantial reduction in the number of students who must participate in the registration process. Other improvements being considered include a centralized registration, on-line drop/add, on-line fee assessment and touch-tone registration.

Accounting for Related Organizations

In September 1987 responsibility for the accounting functions of all of Clemson University's related organizations was transferred from the Division of Institutional Advancement to the Office of Financial Management. These organizations include the Clemson University Foundation, the Clemson Alumni Association, the Clemson University Research Foundation and several unitrusts.

Student and Faculty Housing Revenue Bonds

On May 10, 1988, Series H, I and J of Clemson University's Student and Faculty Housing Revenue Bonds were refunded with the issuance of Series K in the amount of \$14,865,000. As part of the process, the bond issue was evaluated and rated by Moody's Investors Service, Inc., and Standard and Poor's Corp. Previous issues were assigned a rating of "A" by both of these agencies. Series K was assigned a rating of "Aaa" by Moody's and "AAA" by Standard and Poor's reflecting bond insurance from MBIA. Average annual debt services savings of approximately \$294,000 over the life of this issue were realized.

Purchasing and Supply Services

Purchasing serves and supports the entire University in the procuring of goods/services, information technology, consultant services and construction.

During the 1987-88 fiscal year the Purchasing Division issued 889 bids and processed 5,689 purchase orders at a value of \$40 million. Various agency contracts have been established to allow volume buying and reduction in processing time.

The percentage of controllable dollars spent with minority and/or female-owned firms has continued to rise throughout fiscal year 1987-88; first quarter - 2 percent, second quarter - 4 percent, and third quarter - 6 percent. Fourth quarter figures are not yet available.

The University Receiving Station processed 56,928 incoming shipments. To provide better service, an additional delivery truck and part-time employee were added. The University Stores operation processed 29,263 orders during this period. The University Stores catalog is now available through DORIS. There is some editing still to be completed, but it should be fully operational in 1988-89.

The Property Control Section held two public auctions and 13 sealed bid sales yielding a return of \$152,984. The On-Line Property Inventory (OPI) System is now in full operation. This allows departments to obtain property control information directly from the Integrated Data Base Management System (IDMS) connected to the mainframe.

Auxiliary Services

Dining Service

Participation in the University's dining service increased by approximately 800 students in 1987-88. Over 8,100 students were served by the three dining halls during the fall semester. A variety of new dining options, including a renovated canteen and a new credit card, are being implemented for Clemson's students.

University Laundry

The University Laundry increased its revenues by over \$20,000 without benefit of a price increase. The laundry also continued its modernization plan with the addition of several pieces of new equipment. Further enhancements of service are expected during the coming year.

Transportation Services

The Motor Pool also increased its revenues without a price increase. The State Department of Motor Vehicle Management cited the Clemson University Motor Pool as one of the best in the state.

Sponsored Programs

Business and Finance's role is to administer resources received through sponsored programs while creating and maintaining an atmosphere conducive to the successful completion of such programs. The Clemson University Research Foundation (CURF) wrote and produced its first policies and procedures manual, developed its organization and facilities, and created a faculty advisory committee comprised of representatives from each of the nine colleges. Compliance with all applicable policies, procedures and laws governing sponsored program activity was ensured. A Management Information System for sponsored program activities was developed, and an Effort Reporting System continued. Reviews of past audit findings to ensure compliance with applicable accounting, program and audit standards were conducted.

Human Resource Services

During the year, as part of Business and Finance's reorganization, a variety of human resources services received increased emphasis.

Payroll and Fringe Benefits Office

With assistance from the Division of Administrative Programming Services, Publications and Graphics, Personnel and others, the Payroll and Employee Benefits' Office produced the University's first personalized employee benefit statement for all permanent full-time University employees. Entitled "Your Personal Statement of Benefits 1988," the individualized booklets were distributed beginning June 24, 1988.

The Clemson University Payroll Benefits Office was one of the first in the state to implement the IRC Section 125 "cafeteria plan" for Clemson University Employees effective July 1, 1987. This program allows an employee to pay health and dental insurance premiums with before-tax dollars rather than after-tax dollars. This represents approximately a 28 percent savings for employees on health and dental insurance costs.

Risk Management and Safety

This office provides services in the areas of insurance and loss control, safety and workers' compensation. The staff consists of three members: director of risk management and safety, safety coordinator and workers' compensation coordinator.

The Occupational Safety and Health Act (OSHA) Hazard Communication Standard was implemented on schedule. Implementation of the standard included: providing safety training workshops for departments who use hazardous chemicals, establishing a written Hazard Communication Program, and providing Material Safety Data Sheets to laboratories on all hazardous chemicals on the premises.

The State Fleet Safety Program was adopted and an Accident Review Board established. Defensive driving classes were scheduled for employees. Toxic waste removal was coordinated by the safety coordinator. In addition, the department became more aggressive in the monitoring of fume hood systems and made recommendations for improvement in systems in Rhodes and Lehotsky. A recommendation was made to install a sprinkler system in the Hanover House.

Workers' compensation workshops were conducted providing information on benefits, coverage options and claims procedures. Lectures on liability insurance benefits and claims procedures were given to various groups.

Personnel Services

Some of the training and recognition programs for FY 1987-88 offered by Personnel Services were:

- Model-Netics Training in Management Techniques.
- New Staff Employee Orientation Program.
- Managing Employee Performance.
- Employee Education Improvement Program — Offered in cooperation with the Pickens County Adult Education.
- Pre-Retirement Orientation.
- Professional Secretaries International (PSI) — Certified Professional Secretary (CPS) Program.
- Wellness Program.
- Business Systems Workshops.
- The Live Management Telecast of Peter Drucker (held in the Student Senate Chambers).
- An Employee Recognition Program giving:
 - Monthly awards to as many as four non-exempt outstanding employees.
 - Semiannual awards to four exempt employees for excellent performance.
 - An annual awards banquet to recognize all exempt and non-exempt award winners for the year.
- Employee Suggestion Program — Personnel implemented the states' program, which provides financial incentives for employees who submit cost reduction or improved quality-of-life suggestions.

Affirmative Action

The Business and Finance area demonstrated its commitment to affirmative action through an aggressive hiring, training and promotion program for women and minorities.

Facilities Planning and Management

This program area includes planning, engineering, maintenance and management activities of Clemson University's facilities, including master planning, real estate development, and management of land records and property records.

Progress on campus building and renovation programs continues in line with the six-year facilities program approved in September 1987 representing almost \$300 million in projects. More than 40 percent of these projects valued at \$110 million are already under way, including the Strom Thurmond Center, the performing arts center and the conference center. The state of South Carolina has provided funds to initiate the \$15 million engineering innovation center, an \$8.4 million central animal research facility and renovations of Brackett Hall. Plans are under way for an East Campus Activities Center, a new dormitory, an academic learning center and renovations to Johnstone Hall. Improvements in agriculture include funds for architectural and engineering work on the Edisto Experiment Station, for replacement of a fruit research station and for renovations to Newman Hall.

New initiatives under way are a computer study, a space utilization study, a comprehensive facilities audit, and the use of new and various types of construction contract administration methods.

Information Management

Information management includes the development, coordination and maintenance of Business and Finance programs in the area of data processing services, networking, telecommunications, records management, word processing, mail and postal services and other related activities. Emphasis during the year has been to direct the evolution and integration of information processing throughout the organization.

Institutional Research

An institutional research office was established in the Budgets and Planning Office to help the campus establish databases and provide information required in support of University decision-making.

Telecommunications

In 1987-88 the Office of Telecommunications tested and adopted the use of new cabling interface equipment that allows certain high-speed data terminals to communicate over standard telephone wiring. Telephone wiring that is already in place is used in most cases to provide communications between the data terminals and the network controllers. Even when new wiring has to be placed, the telephone wiring is much cheaper and easier to install than the previously required coaxial cables. During the year, several systems were installed with the new technology, saving thousands of dollars in cabling and conduit costs.

Other projects completed during 1987-88 are:

- Consolidated the University Switchboard and the Student Locator Service into a more efficient single unit, the Call Assistance Center.
- Solicited proposals and awarded a new agreement for publishing the University Directory.

- Implemented an automated order processing system.
- Solicited bids and awarded term contracts for new telephone systems for several Extension offices, Memorial Stadium and Littlejohn Coliseum.
- Rewired Barnett Hall as part of the asbestos abatement project.
- Modified the student billing system to stagger billings throughout each month.
- Implemented a cash register operation to accept cash payments of student telephone bills.

Administrative Data Processing

Continued improvements in data processing, word processing and the centralized microfilm unit were achieved during the year. Future plans involve exploring a variety of distributed data entry options for Business and Finance.

Business Systems Development

A number of financial information systems were developed within Business and Finance, thereby improving productivity and internal control.

Information Resources

Business and Finance continued to develop a variety of networking and office automation systems throughout the organization.

Information Support Services

Printing Services provides printing and duplicating services to the University. In addition to offset printing and high-speed photostatic duplicating, document assembly, finishing, folding, inserting labeling and bulk mail services are provided. Printing Services imprints over 28,000,000 pieces of paper each year.

Projects completed in 1987-88 include:

- Implemented automated systems for cost estimating, job control and inventory.
- Negotiated an agreement with the University Union to locate a copy shop operation for students in the Union complex.
- Initiated a new typesetting service for the campus.

Postal services are provided on campus by the University Post Office. Incoming U.S. mail and campus mail are delivered to students via more than 7,000 boxes located in the Post Office lobby. Stamp and money order sales, parcel, insured, certified and registered mail services are also provided at the lobby counter. Mail pickup and delivery service is provided to faculty and staff office complexes. The University Post Office, which processes about 40,000 pieces of mail and 250 parcels daily, continues to develop a variety of automation initiatives to improve service and reduce costs.

Systems Development

In the search for improved service at a reasonable cost, consultants can be of considerable value. In many cases their proposed methods have been proven by the experience of other campuses. Examples of the benefit of using such resources range from using national accounting firms to modify Clemson University's indirect cost base

resulting in income exceeding \$80,000 annually, to using consultants to help reorganize facility operations and improve campus space utilization.

Another valuable tool in the area of cost containment is contracting with private enterprise to perform a service at a lower cost. Concerns have been expressed that such arrangements may conflict with public policy. However, if handled in an open manner, they can yield considerable benefits to a governmental enterprise. Examples include:

Loan Billings and Collections: Using an outside firm to handle collections resulting in \$60,000 in annual savings.

Computer Center: Recently computer operations moved into a new high-tech computer facility. The approach to this project was unique to facilities within South Carolina, and the privatization concept utilized in bringing the project together has proven a resounding success. The University's approach utilized a Request for Proposals, which not only fully complied with the State Procurement Code, but also allowed a great deal of innovation. A single entity (the developer) was selected by the University to provide architectural, engineering, construction, legal and investment banking services instead of dealing with separate entities for each discipline. In addition, the developer was at risk during the design, construction and finance phases of the project while Clemson maintained control of the project in detail on a daily basis.

The real efficiencies resulted in the timely completion of an outstanding facility (approximately 20 months from inception to completion) at a reasonable cost. Clemson, therefore, avoided the upward pressures of inflation on construction costs and the rise in interest rates since completion of the project. The net effect has resulted in an annualized rental rate to Clemson of approximately \$483,000 per year as compared to today's rate, which would approximate \$577,000. Over the 20-year lease period, this is a direct savings of approximately \$1.9 million.

Water Plant System: Due to a consent order issued by the South Carolina Department of Health and Environmental Control, Clemson submitted a \$5.9 million request for water filtration plant improvements in this year's Capital Improvement Bond Bill. Concurrently, Clemson University commissioned Black & Veatch Engineers to study Clemson University's water plant operations. The study presented several alternatives, the most attractive and economical of which was the purchase of potable water from an outside source. This alternative has been accepted, and during FY 1989 Clemson University shall contract with an outside source for purchase of the product. This approach will significantly reduce costs over a 20-year period.

Other Initiatives: Other cost-containment efforts range from the creation, in cooperation with the University Library, of a Records Center with significant savings expected in terms of time, money and space; acquiring copiers at a savings of \$100,000 in copy production cost during the life of these copiers; reducing medical insurance costs \$60,000 annually; achieving energy savings of over \$250,000 annually through a variety of management programs; and developing NACUBO- and AICPA-based management systems for permanent improvements resulting in cash management, construction cost and architect fee savings ranging from \$100-250,000 annually depending upon the level of activity.

INSTITUTIONAL ADVANCEMENT

The Division of Institutional Advancement is designed to create and enhance Clemson University's communication and support programs. The division consists of the offices of University Relations, Alumni Relations, Development and Advancement Services. These units work with the Clemson University Board of Visitors, the Clemson Alumni Association and the Clemson University Foundation to communicate the mission and activities of the University and to enhance its image; to provide service and programming to Clemson alumni and friends and to seek service and broad support from alumni and friends; to attract and manage private financial gifts in support of Clemson academics and administrative operations; and to manage the constituent database and computer systems necessary for the aforementioned endeavors to occur. A report on each unit follows.

University Relations

Communication is the common theme for the six units that comprise University Relations. These departments provide services in the areas of news and public information, electronic and photographic support, publications and graphics, visitor programs, constituent communications, general public relations counsel, and long-range strategic communications planning for the University's academic and administrative divisions, including the Cooperative Extension Service and the S.C. Agricultural Experiment Station.

Agricultural Communications

The Department of Agricultural Communications serves the communications needs of the public service agencies in the College of Agricultural Sciences. A primary goal is to provide the people of South Carolina information that will help them improve their productivity and standard of living. This is accomplished by providing news articles, columns and features for the general media, both print and broadcast, and for specialized publications; by providing agriculture, health, nutrition, home care and other publications of value to growers, homeowners, families and young people; by developing exhibits for use throughout South Carolina; and by working with Extension employees to develop their communication skills.

In 1987-88, the department:

- Planned and conducted, in conjunction with News Services, the communications effort for the Clemson biotechnology effort. This activity won the University a national gold medal from the Council for Advancement and Support of Education.
- Handled 491 publication, exhibit and display assignments.
- Issued 395 news releases.
- Produced a daily five-minute agricultural news radio program for the S.C. Network.
- Generated 26 television stories that ran on stations throughout the state, four on the Cable News Network, and one for the Boston affiliate of ABC News.

Constituent Communications

The primary role of the Constituent Communications program is to help the University keep constituent audiences (primarily alumni, donors and other supporters) informed and educated about Clemson. The major "products" of this effort are the periodical publications *Clemson World* (magazine, circulation 30,000) and *Clemson World News* (tabloid newspaper, circulation 75,000). Staff members also provide editorial and communications counsel and support for special projects, such as the University's Centennial celebration, which began in April 1988. In 1987-88, the program:

- Completed the merger of the magazine and tabloid; introduced a new name for the tabloid and a new design for both publications.
- Prepared and published four issues each of *Clemson World* and *Clemson World News*, including special issues on private support (the "Honor Roll" issue) and on research.
- Assisted the president, vice presidents and other administrators with special communications projects, as needed, including the "President's Report," the "President's Letter" (a biweekly newsletter) and notes for speeches.
- Provided leadership for planning and publicizing Centennial events.
- Provided communications counsel and leadership for academic fund-raising activities, such as the announcement of major gifts.
- Worked with the Alumni Communications Task Force and began implementing recommendations, including a standing column for the Alumni Association president in *Clemson World News*.

Electronic and Photographic Services

The Department of Electronic and Photographic Services (commonly known as the Communications Center) provides a broad range of audio and visual production services to support the public service, administrative, development, research and instructional activities of the University.

Services include television, audio, multi-image, photographic and cinematographic production, audio and video teleconferencing, art and graphics support, and audio-visual equipment and resources loans.

In 1987-88, the department:

- Worked with a Clemson University mathematics professor to produce a motivational videotape about math for middle school students. One thousand copies of the tape, produced under a contract with the Mathematics Association of America, were distributed nationwide.
- Completed development of and put into service the Instructional Television Classroom, from which Clemson graduate courses are broadcast to locations across the state.
- Produced one statewide and two national satellite teleconferences.
- Began producing and distributing a monthly television program called "CUE Magazine" (for Clemson University Extension).
- Produced 514 television program units.

- Produced 41,275 photographs and 31,275 slides.
- Completed 2,143 art-and-graphics jobs, representing nearly 17,000 individual pieces of artwork.
- Produced 260 daily "Plant Professor" radio programs distributed to 65 stations and 52 "Living Well" programs for 43 stations.
- Produced more than 100 sound tracks for various multi-image and video projects.
- Produced 47 one-, two- and three-projector presentations.
- Increased the Media Library's holdings to 2,005 titles. The library averaged 50 loan transactions per week during the year.
- Complied with an average of 60 requests per week for items from the Audio-Visual Loan Service.

News Services

The Department of News Services provides the University with a means of communication to the public through external news media and internal news vehicles, such as the faculty-staff newsletter. Staff members generate news and feature stories about the University's educational, public service and research programs for use by state, regional and national news media and in constituent publications, such as *Clemson World* magazine and *Clemson World News* tabloid. Services also include editing and marketing faculty-written columns and book reviews; coordinating coverage of campus events, speakers and Board of Trustees meetings; conducting news conferences and major public relations campaigns; and acting as liaisons between the University and the print and broadcast media.

In 1987-88, News Services produced:

- 461 general news releases.
- 43 news media tip sheets.
- 53 history book review columns.
- 51 children's book review columns.
- 53 "Living Well" columns.
- 21 editorials.
- 4 feature packets (back-to-school, 8 releases; Christmas, 14 releases; Centennial, 11 releases; tourism, 10 releases).
- 968 hometown news releases.
- 44 regular and 11 special issues of *Clemson Weekly*, the faculty-staff newsletter.
- 7 calendars of events.
- Daily "Executive News Briefings."
- Public relations plans and arrangements for the Centennial, six major-gift announcements, and numerous research features and announcements, including announcement of the largest research contract in Clemson history.

Publications and Graphics Services

The Department of Publications and Graphics Services ensures that Clemson University's printed communications maintain the highest standards of writing and design and that they project an accurate image to the University's various publics. To that end, a professional staff of writers, designers and production personnel provides

the services needed to create and coordinate a publication project from the planning stage through delivery of the finished product.

In 1987-88, the department:

- Completed 540 projects (including 50 Centennial projects).
- Became established as a campus source of expertise in desktop publishing.
- Played an active, advisory role in University Printing Services' new typesetting endeavor.
- Conducted several publication production workshops for University departments and local public schools.
- Specified, installed and were trained on a new computer system, the Apple Macintosh network.
- Installed a scanner that eliminates the need for re-keying material being prepared for publication.
- Received from Apple Computer a gift of hardware and software valued at about \$500 that permits direct exchange of computer disks with clients.
- Continued to refine methods for tracking job costs in an aggressive, ongoing effort to find ways to save the University money.
- Commissioned an external, professional publications audit in an effort to improve operational procedures and increase production efficiency.

Visitor Programs

Visitor Programs administers the Visitors Center, Board of Visitors activities and two campus landmark houses — Fort Hill and Hanover House. The University's full-service Visitors Center provides a variety of services to meet the information needs of an increasing number of campus visitors. Services include general information, guided and self-guided tours, audio-visuals and publications. Through the Board of Visitors program, prominent civic and business leaders serve as advisers to the University, visit the campus for updates on University programs and priorities, and help provide a two-way communications link between the University and the public. Members of the board are assigned to four committees: academic affairs, legislative relations, media and research. The historic Fort Hill and Hanover House are open to the public throughout the year.

In 1987-88:

- The Visitors Center served 20,481 people, conducted 531 regularly scheduled guided tours, arranged an additional 251 tours, and both arranged and guided 76 special tours.
- The Board of Visitors met once in full session, held two, one-day, committee working sessions on campus, and hosted a Legislative Reception in Columbia in March.
- 10,880 people visited Fort Hill and 4,013 visited the Hanover House.

Alumni Relations

The Alumni Relations Office provides a variety of programs and services for Clemson alumni, friends, students and students' parents. In 1987-88 the office organized its

functions into three programmatic areas: Alumni Programs, Field Activities and Special Events. Highlights from each area follow.

Alumni Programs

This area is responsible for planning, directing and overseeing all campus-based, alumni-related programs and for working with special groups of alumni and students, such as the Young Alumni Associates, the Student Alumni Council and the Clemson Black Alumni Council.

In 1987-88:

- There were more than 50 Young Alumni activities in 15 cities with an average attendance of 50. Among other accomplishments, the Young Alumni Associates began an awards program to recognize top high school students and encourage them to choose Clemson for college.
- The Student Alumni Council hosted the largest ever Welcome Back Festival to start the academic year, conducted the eighth annual Orange Carpet Day for outstanding high school students, won a Gold Medal from the Council for Advancement and Support of Education for hosting the 1987 national convention of student alumni associations and student foundations, and selected Dr. Gene Bishop, a professor of mechanical engineering, as the 1988 Alumni Master Teacher.
- The staff planned and produced Reunion Weekend '88.
- The Clemson Black Alumni Council planned a public dinner to celebrate the early success of an effort to raise at least \$1 million to endow scholarships for black students and to mark the 25th anniversary of the enrollment of Clemson's first black student, former Charlotte, N.C., Mayor Harvey Gantt.
- More than 6,000 Clemson Credit Cards (special VISA and MasterCard charge cards) were issued under an agreement with South Carolina National Bank.
- The Clemson Travel Program was revamped to place greater emphasis on continuing education opportunities.
- Various campus groups used the Clemson Alumni Center 200 days for education and administrative purposes.

Field Activities

This area is responsible for planning, directing and overseeing off-campus, alumni-related programs, with particular emphasis on encouraging the development and growth of locally based Clemson Clubs throughout the state, region and nation.

In 1987-88:

- There were more than 130 Clemson Club activities around the country.
- The first Clemson Club Officers Weekend attracted 97 participants, some from as far away as California and Texas, for educational sessions about club development, operation and programming.
- Clemson Clubs and Clemson Extension Service offices coordinated 42 off-campus ceremonies to help begin Clemson's Centennial celebration.
- Alumni Headquarters and related events were provided for three regular-season away football games, the Citrus Bowl and the Atlantic Coast Conference basketball tournament.

- More than 11,000 alumni received the weekly *Alumni Career Services Bulletin* of career opportunities.

Special Events

This area assists all Institutional Advancement departments and other University divisions in planning and producing special events (on and off campus) to enhance Clemson's image and to meet particular constituent or program needs.

In 1987-88:

- The Clemson Alumni Association and City of Clemson co-hosted a reception in August to welcome new faculty members to the campus and community.
- A public appreciation dinner for Clemson President-Emeritus Walter T. Cox was held in September.
- The seventh annual Clemson Medallion Dinner was held in September honoring Robert Campbell '37 and P.W. McAlister '41, and the eighth was held in April honoring George Aull '19 and Louis P. Batson Jr. '48.
- The first Clemson Parents' Weekend was held in September.
- Dedication of the Tillman Hall Memorial Carillon was held in October.
- Eight appreciation dinners were held for Clemson benefactors.
- Special events were held for each of Clemson's three major gift clubs and for the new Benefactors of 1889 group.
- Opening ceremonies for the Clemson Centennial celebration were held in April.
- The staff assisted with numerous other special events, from Homecoming to graduation.

Development Office

The objectives of Clemson's private support efforts are deliberate and broad-based. They encompass growth in the unrestricted permanent endowment, expansion of all phases of general and endowment support for faculty, increased sources of student financial aid and further development of the annual Loyalty Fund program, which enhances the total academic environment. While state appropriations are a part of the total support for the educational activities at Clemson, more than 50 percent of the total budget must come from other sources. In that context, the ultimate quality of the University rests with private support from business, industry, alumni and friends of the University.

In 1987-88:

- Private gifts for Clemson's academic programs jumped a phenomenal 40.2 percent, reaching \$10.3 million and crossing into double digits for the first time in history.
- Unrestricted giving to the annual Clemson Loyalty Fund topped \$1 million for the first time ever.
- A record number of individuals — 14,592 — made annual gifts to current operations. The average of these gifts was \$85.
- Of Clemson's alumni of record, 26.5 percent — twice the national average for state-assisted schools — participated in the Loyalty Fund.

- New gifts were received from 1,280 donors who had never given before.
- Of the \$10.3 million total, \$5.2 million came from individuals, \$3.2 million from corporations, and \$1.9 million from foundations and trusts.
- A total of 17,878 gifts — including gifts for annual operations and for capital purposes, from individuals and from organizations — were received in 1987-88. The average gift from all sources was \$399.
- Total expenditures relative to year-end fund-raising results indicate a cost of 10 cents to raise each dollar.
- The year included announcements of major gifts and bequests that will lead to the establishment or significant enhancement of: The Robert and Lois Coker Trustees Chair in Molecular Genetics, The P.W. and Bobbie McAlister Trustees Chair in Advanced Engineering Materials, The Callie Jones Shirley Library Endowment, The George J. Bishop III Distinguished Professorship in Ceramic Engineering, The Milton W. Holcombe Chair in Electrical and Computer Engineering, The Prince Presidential Scholars Endowment and The James A. "Shine" Milling Presidential Scholarship Endowment.
- The S.C. Dairy Science Association voted to raise \$200,000 a year for the next five years to endow a Chair in Clemson's Dairy Science Department.
- Preparations were made to announce a drive to raise at least \$1 million for The Harvey B. Gantt Scholarship Endowment Fund, which will provide scholarships for black students and honor Clemson's first black student, former Charlotte Mayor Harvey Gantt.

Advancement Services

The Office of Advancement Services was created in 1987 to provide support for the entire Institutional Advancement division. The office is responsible for receiving and processing private gifts, endowment management, database management, and alumni and development systems programming. The office is responsible for financial analysis; daily, semi-monthly, monthly and annual reporting of fund-raising results; and financial management, including all transactions on behalf of the Clemson University Foundation. Further, the office is charged with the management, through three professional investment managers, of the Foundation's endowment of more than \$25 million.

In 1987-88:

- Personnel, technology, processes, equipment, standards, reporting relationships and support systems were reviewed, revised and established to create a functionally efficient and effective service unit.
- The office provided staff support for the Clemson University Foundation Board of Directors, which revised the Foundation's constitution and implemented a new committee structure.
- 17 personal computers were installed throughout the division, with the Office of Advancement Services providing the requisite training on the new equipment and systems.
- A process for conducting fund-raising cost/benefit analysis was begun, following standards recently published by the Council for Advancement and Support of Education.

STUDENT AFFAIRS

The 1987-88 academic year marked the highest on-campus enrollment with 12,870 students registered for classes — 11,639 full time and 1,231 part time. An additional 995 were in various off-campus programs, bringing the total enrollment to 13,865, a slight increase over last year. Of the total enrollment, 2,895 were graduate students.

The College of Engineering again had the highest on-campus enrollment with 3,460 students. The College of Commerce and Industry was second with 2,964, followed in order by Sciences (1,546), Education (1,480), Liberal Arts (1,301), Agricultural Sciences (585), Architecture (583), Forest and Recreation Resources (529) and Nursing (316).

Higher education continued to become increasingly accessible as evidenced by the number of freshmen entering college with advanced standing. In the 1987-88 fall semester, new high school graduates entered Clemson with advanced standing by means of College Board Advanced Placement courses (626 students, 5,434 credit hours) and by concurrent enrollment in high school and college or enrollment in summer school (138 students, 720 credit hours).

At Clemson, performance in high school has proven to be the best single predictor of success in the freshman year. The class ranks of entering freshmen remained essentially unchanged, with 33 percent of the class entering in fall 1987 ranked in the top 10 percent of their class, 57 percent in the top 20 percent and 93 percent in the top 50 percent. The freshman class average Scholastic Achievement Test (SAT) score of 1,028 compared with an average of 906 reported by the College Board for all high school seniors. It is also the highest average among state-supported institutions in South Carolina.

Of the 8,310 new applications for admission processed for 1987-88, 5,892 were accepted, and 3,299 actually enrolled (including freshmen and transfer students). Clemson students come from all 46 South Carolina counties, 49 states, Puerto Rico, the District of Columbia, the Virgin Islands and 71 foreign countries.

South Carolina residents accounted for 66 percent of the 13,865 students, including those enrolled in off-campus programs. Greenville County continued to have the most students enrolled on campus (1,100). Pickens County was second with 923, followed in order by Anderson, Oconee, Spartanburg and Charleston counties. Most out-of-state students came from Georgia (564), North Carolina (537) and Florida (490).

Computerized pre-registration helped the record number of students get off to a smooth start for fall classes. Approximately 87 percent were pre-registered and had their course schedules completed before they arrived on campus to begin classes.

Fall Semester Enrollment Comparisons for Recent Years

Year	Undergraduate	Graduate and Others	Total
1972-73	7,686	2,071	9,757
1973-74	7,910	2,202	10,112
1974-75	8,171	2,415	10,586
1975-76	8,576	2,785	11,361
1976-77	8,620	2,763	11,383
1977-78	8,708	2,566	11,274
1978-79	8,925	2,553	11,478
1979-80	9,291	2,457	11,748
1980-81	9,427	2,152	11,579
1981-82	9,918	2,008	11,926
1982-83	10,151	1,983	12,134
1983-84	10,217	2,242	12,459
1984-85	10,488	2,438	12,926
1985-86	10,434	2,459	12,893
1986-87	10,360	2,702	13,062
1987-88	10,970	2,895	13,865

The 1987-88 figures include 764 students attending off-campus institutes and 162 in the Clemson-Furman University Master of Business Administration degree program.

The on-campus enrollment of women at Clemson reached an all-time high during the 1987 fall semester. There were 6,107, of which 4,736 were undergraduates. Enrollment of undergraduate women increased over 5 percent from last year, and women now constitute approximately 43 percent of the on-campus undergraduate enrollment.

The Clemson student body continues to be a working group, receiving a significant amount of financial assistance in the form of loans, grants, scholarships and employment. Clemson awarded 304 long-term loans totaling \$334,000. The University also approved and certified 3,096 guaranteed student loans from a variety of lending institutions. Excluding donor-selected scholarships, 1,125 scholarships and grants valued at \$1,022,203 were awarded. The number of students receiving Pell Grants was 1,278 with awards totaling \$1,707,302. In all, about 68 percent of the student body received an estimated total of \$21 million in financial assistance.

Students at Clemson University enjoyed educational experiences outside the classroom through participation in one or more of over 260 student organizations. Half of these groups directly complement the academic experience by providing career-oriented fellowship, programs and trips to professional conferences. Our students also enjoy competition, socialization and fellowship in sports, social and religious organizations. In addition, more than 40 groups have been formed to associate students interested in fine arts, media, military, government and community service.

Student Government continues to add new programs for the student body. Approximately 350 people this year represented the students in the senate, in the judicial system, on executive committees, and 95 students were appointed to University committees. The shuttle system operated by Student Government was extended this year, and the students coordinated a fundraiser that raised \$7,500 for the U. S. Olympic Committee.

The *TAPS* yearbook, *The Tiger* newspaper, WSBF radio and *The Chronicle*, Clemson's variety magazine, continue to offer positive outlets for students' creative energies. *TAPS* had a banner year selling over 6,700 books, the largest number in Clemson history.

Clemson's 12 sororities and 18 fraternities grew in popularity during the past year and claimed 23 percent of the undergraduate population as members. With the renovation of a floor in Fike Center for the Pan Greek Council groups, all of the Greek organizations have obtained office and lounge space on campus.

In other areas of student life, over \$40,000 of grant funding was generated to provide alcohol education programs and minority student retention programs. Partially as a result of these programs, the University evidenced a 19 percent decline in alcohol disciplinary incidents from 1985-86 and distributed a University policy on racial harassment.

The Counseling and Career Planning Center had a very successful year. On March 31, 1988, the center met and exceeded all criteria for accreditation from the International Association of Counseling Services. Students are provided quality mental health services so as to improve their ability to make good decisions, achieve educational and career goals, and become productive members of the state and nation.

Career Services, composed of Placement and Cooperative Education, provides students with information on career opportunities, teaches job search skills, offers the chance for work experience and coordinates industry contacts with the University.

The new computerized sign-up system was brought on line in the fall and revolutionized the interview schedule procedure. Students can now research an employer and sign up for interviews from any of some 800 terminals on campus. Interview activity and salary offers were about the same as last year in engineering but up significantly in accounting and computer science.

Cooperative Education continued to grow this year with student enrollment reaching 700 and students earning \$4.2 million. Effective July 1, 1988, Cooperative Education was placed under the cognizance of Academic Affairs.

The University Union continues to provide an atmosphere where students can develop skill in leadership, communications, business and interpersonal relationships, while providing worthwhile services and co-curricular events for the total campus population. The Union Board, comprised of more than 250 student volunteers, presented over 725 programs in 1987-88.

Highlighting this year's Performing Artist Series was Dizzy Gillespie, who opened the series, and the Chinese Golden Dragon Acrobats, who played to a full house. The Homecoming attraction in Littlejohn Coliseum featured the legendary Fleetwood Mac. Other coliseum performers were R.E.M., Def Leppard, Jimmy Buffett and Wynton Marsalis. Rounding out the year's events was the annual First Friday spirit concert in the amphitheater and The Drive-In Movie, which was chosen the 1987 Program of the Year.

In many ways 1987-88 was Clemson's most successful athletic year ever. The Tigers won five conference championships, a national championship and New Year's Day football game. Football, women's swimming, men's cross country, men's tennis and golf were conference champions. Clemson had 10 teams finish in the top 20 in the nation, which tied a school record. The men's program was ranked 8th in the nation in overall programs, and the women's program was ranked 28th in the nation.

**Number and Percent
of Black Students**

Year	Number	Percent
1972	179	2
1973	211	2
1974	216	2
1975	338	3
1976	307	3
1977	336	3
1978	290	3
1979	341	3
1980	305	3
1981	325	3
1982	429	4
1983	472	4
1984	528	4
1985	671	5
1986	714	5.47
1987	690	5

**Average College Board
of Freshmen**

Year	Score
1972	995
1973	982
1974	984
1975	983
1976	996
1977	985
1978	1,000
1979	1,002
1980	1,005
1981	1,007
1982	1,017
1983	1,014
1984	1,012
1985	1,012
1986	1,025
1987	1,028

**Student Faculty Ratio
(Full-Time Equivalent)**

Year	Ratio
1972	14.6:1
1973	16.8:1
1974	17.9:1
1975	18.3:1
1976	17.6:1
1977	16.3:1
1978	15.9:1
1979	16.0:1
1980	15.6:1
1981	16.4:1
1982	16.6:1
1983	17.0:1
1984	16.1:1
1985	15.4:1
1986	16.9:1
1987	18.3:1

**Number in Freshman Class
(New Students)**

Year	Number
1972	1,919
1973	2,034
1974	1,949
1975	1,901
1976	1,861
1977	1,838
1978	2,020
1979	1,998
1980	2,008
1981	2,284
1982	2,321
1983	2,122
1984	2,188
1985	2,259
1986	2,239
1987	2,818

**Number of Teachers
(Full-Time Equivalent
Teaching Faculty)**

Year	Teachers
1972	614.9
1973	578.4
1974	591.8
1975	602.5
1976	611.3
1977	654.4
1978	675.6
1979	691.8
1980	718.2
1981	709.7
1982	720.9
1983	713.5
1984	762.5
1985	797.3
1986	731.24
1987	713.93

**Number of Dorm Beds
and Percent Being Used**

Year	Beds	Percent
1972	5,174	100
1973	5,330	102
1974	5,592*	101
1975	5,616*	103
1976	5,625*	103
1977	5,662*	103
1978	5,683*	104
1979	5,726*	106
1980	6,317*	112
1981	6,864*	100
1982	7,149*	105
1983	7,113*	104
1984	6,976*	102
1985	6,986*	102
1986	6,910*	101
1987	7,047*	103

* Includes beds in the Clemson House.

1974 - 252	1981 - 330
1975 - 262	1982 - 328
1976 - 271	1983 - 331
1977 - 308	1984 - 331
1978 - 317	1985 - 333
1979 - 324	1986 - 349
1980 - 329	1987 - 360

**Number of On-Campus Students
in Summer School**

Year	Number
1972	5,232
1973	6,267
1974	5,997
1975	6,275
1976	6,100
1977	6,301
1978	6,393
1979	6,708
1980	6,858
1981	6,897
1982	7,149
1983	7,442
1984	7,418
1985	8,126
1986	8,562
1987	8,446

1987-88 Clemson Sports

Sport	Home	Away	Neutral	ACC	Overall	PCT.	ACC Regular Finish	ACC Trn. Finish	National Ranking	1st Team All-ACC Players	All America Players**	Academic All- Americans
*Football	7-1	2-1	1-0	6-1	10-2	.833	1st	na	10th	3	4	0
Soccer	13-1	3-3-1	0-1	2-5-1	18-5-1	.771	5th	T5th	1st	3	2	0
Women's Cross Country	--	--	--	--	--	--	na	3rd	13th	0	0	0
*Men's Cross Country	--	--	--	--	--	--	na	1st	11th	4	0	0
Volleyball	9-6	8-7	4-3	3-3	21-16	.568	5th	T5th	--	1	0	1
Men's Basketball	12-4	0-9	2-2	4-11	14-15	.483	7th	T5th	--	0	0	0
Women's Basketball	12-2	7-6	2-1	8-6	21-9	.700	4th	T3rd	20th	1	0	0
Wrestling	5-2	3-1	3-2	3-2	11-5	.688	3rd	4th	--	3	0	0
*Women's Swimming	4-0	5-0	0-0	4-0	9-0	1.000	1st	1st	5th	4	8	0
Men's Swimming	3-1	2-3	0-0	2-2	5-4	.556	3rd	3rd	22nd	1	0	0
Women's Indoor Track	--	--	--	--	--	--	na	4th	--	1	0	0
Men's Indoor Track	--	--	--	--	--	--	na	3rd	--	5	1	0
Baseball	30-2	14-6	10-6	18-2	54-14	.794	1st	3rd	15th	3	2	0
Women's Tennis	9-2	5-4	4-4	6-1	18-10	.643	2nd	3rd	22nd	2	0	0
*Men's Tennis	6-1	6-2	10-6	6-1	22-9	.710	2nd	1st	10th	2	0	0
Women's Outdoor Track	--	--	--	--	--	--	na	4th	--	1	0	0
Men's Outdoor Tack	--	--	--	--	--	--	na	3rd	T15th	4	0	0
*Golf	--	--	--	--	--	--	na	1st	17th	3	2	0
Men's Totals	76-12	30-25-1	26-17	41-24	134-52	.713	2 Firsts	3 Firsts	7 Top 20	31	11	0
Women's Totals	34-10	25-17	10-8	21-10	69-35	.663	1 First	1 Firsts	3 Top 20	10	8	1
Overall Totals	110-22	55-42-1	36-25	62-34	203-89	.695	3 Firsts	4 Firsts	10 Top 20	41	19	1

*Denotes ACC Championship.

**Fall Semester 1987 Enrollment by Colleges and Degrees Awarded
December 1986-August 1987**

	Total Enrollment Fall Semester	Degrees					Total
		Associate	Bachelor's	Master's	Specialist	Doctorate	
Agricultural Sciences	587	0	98	48	0	13	159
Architecture	594	0	85	40	0	0	125
Commerce & Industry	3162	0	585	93	0	9	687
Education	2160	0	216	164	6	3	389
Engineering	3460	0	577	130	0	18	725
Forest & Recreation Resources	531	0	75	9	0	4	88
Liberal Arts	1301	0	150	14	0	0	164
Nursing	330	0	86	11	0	0	97
Sciences	1547	0	226	68	0	17	331
Non-Degree	193						
TOTAL	13,865	0	2,118	577	6	64	2,765

Degrees awarded since 1896 (through August 1987) total 62,669 of which 426 have been associate degrees; 50,313 bachelor's degrees; 10,888 master's degrees; 141 education specialist degrees; and 901 doctorates. Includes 504 Clemson-Furman MBA degrees awarded May 1972-August 1987.